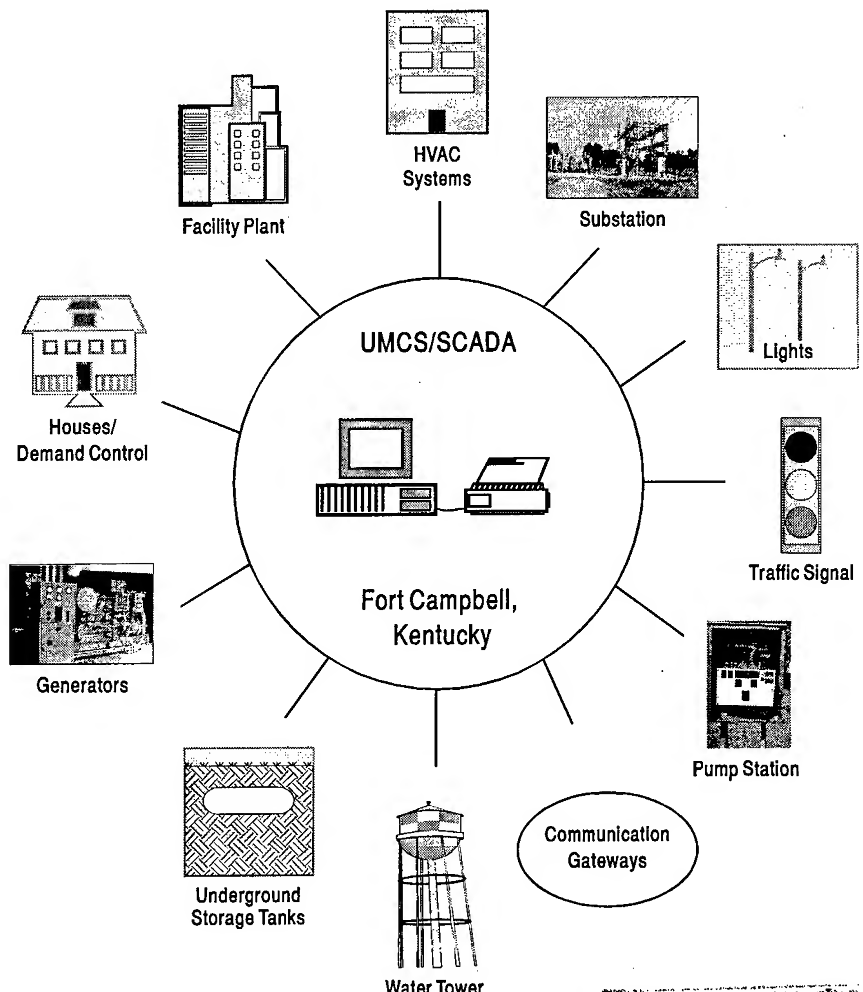
FEASIBILITY STUDY, FY95S EEAP
Utility Monitoring & Control System (UMCS)/
Supervisory Control and Data Acquisition (SCADA) System
Fort Campbell, Kentucky

Final Report



CONTRACT #DACA01-94-D-0034
SYSTEMS CORP PROJECT #94013.08
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Louisville District-
US Army Corps
of Engineers

SYSTEMS*corp*

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1.0 EXECUTIVE SUMMARY

1.1 SYNOPSIS

Systems Engineering and Management Corporation (Systems Corp) performed a feasibility study on the application of the Utility Monitoring and Control System (UMCS) at Fort Campbell, Kentucky for US Army Engineer District, Louisville, under Contract No. DACA01-94-D-0034, Delivery Order No. 0008. The study evaluated the economic benefits of monitoring and controlling various facility and utility systems at the Fort through the use of the UMCS.

The UMCS is a utility monitoring and control system that utilizes several computer stations with appropriate application software connected by communication network systems (wire, radio, power line carrier or fiber optics) to a number of remote terminal units placed at various locations to perform the following functions: collect data, perform remote and local controlling functions, initiate alarm conditions, and report the information through the communication network back to the computer stations.

The study resulted in a recommendation for the implementation of the Utility Monitoring and Control System at Fort Campbell under one project. The implementation of the UMCS project will save Fort Campbell $1,348,383 annually. The project will pay for itself in 3.65 years.

1.2 FEASIBILITY STUDY REQUIREMENT

The UMCS feasibility study evaluated the economic benefits of monitoring and controlling various facility and utility systems at Fort Campbell, Kentucky. Potential savings associated with the UMCS include energy savings, maintenance and operation labor cost savings, and cost avoidance due to equipment failures. The general requirements of the Scope of Work are listed below:

- ➪ Review for general information the available design, construction, documentation, and operation data for the existing EMCS (Energy Monitoring and Control System) and the existing facility and utility systems on Fort Campbell.

- ➪ Perform a feasibility survey and study of specific facility and utility systems in order to collect the necessary data for the evaluation and analysis of the UMCS applications and Energy Conservation Opportunities (ECOs).

- Evaluate UMCS application programs (software) for all facilities using similar data to determine the ECOs and economic feasibility for connection to the recommended new UMCS.

- Provide complete programming or implementation documentation for all recommended projects detailed herein.

- Prepare a comprehensive report to document work performed, the results, and recommendations.

1.3 FACILITY AND UTILITY SYSTEMS EVALUATED

The study evaluated the economic benefits of utilizing the UMCS/SCADA system to monitor and control Fort Campbell's facility and utility systems. Each system has an assigned ECO (Energy Conservation Opportunity) number. The facility and utility systems evaluated under this study are:

ECO 1: HVAC Systems
ECO 2: Electrical Substations
ECO 3: Emergency Generators
ECO 4: Water System
ECO 5: Sewage Treatment System
ECO 6: Remote Metering System
ECO 7: Underground Storage Tanks
ECO 8: Athletic-Field Lights
ECO 9: Traffic Signal Lights

1.3.1 Energy Costs

The costs for each type of energy source used in the study were obtained from the installation is utility bills and through the Defense Energy Information System (DEIS).

1.3.1.1 Electricity

Cost/kWh = $ 0.0211/KWH (No Demand)
Cost/kW = $ 11.78/kW
Cost/MBtu = $ 6.19/MBtu (No Demand)

1.3.1.2 Fuel Oil #2

Cost/MBtu = $5.62/MBtu

1.3.1.3 Natural Gas

Cost/MBtu = $4.35/MBtu (Summer Average)

1.4 SUMMARY OF ANALYSIS RESULTS

Life-cycle cost analyses were performed on each of the ECOs. The *Life-Cycle Costing in Design (LCCID)* computer program was used to performed the analysis. The study analyzed the potential savings and costs resulting from the implementation of the UMCS at Fort Campbell. The potential savings and costs data are input into the life-cycle analysis calculations. The results of the life-cycle analysis for each of the ECOs are shown in *Table 1.4.1. Table 1.4.2* shows the results of the life-cycle analysis for the overall project which incorporated all of the ECOs.

Table 1.4.1
UMCS/SCADA ECOs
LIFE-CYCLE COST ANALYSIS SUMMARY

ECO No.	Investment ($)	Energy Savings (MBtu)	Demand Savings ($)	Non-Energy Savings ($)	Non-Recurring		First Year Savings	Simple Payback	SIR
					Savings ($)	Yr OC			
1	$2,242,700	87,703	$19,551	$47,200	$1,104,655	5	$564,213	3.99	2.32
2	$1,099,014	0	0	$205,000	$120,000	5	$217,000	5.06	1.69
3	$420,119	(10,332)	$381,672	$74,146	0	0	$397,752	1.06	7.93
4	$68,970	0	$55,000	$14,600	0	0	$69,600	0.99	8.61
5	$225,500	0	0	$14,600	0	0	$14,600	15.45	0.55
6	$628,014	0	0	$24,408	0	0	$24,408	25.73	0.33
7	$30,152	0	0	$1,600	$18,700	5	$3,470	8.69	0.99
8	$52,201	243	$54,067	0	0	0	$55,571	0.94	9.08
9	$154,574	72	$339	$984	0	0	$1,769	87.40	0.10

Table 1.4.2
UMCS/SCADA OVERALL PROJECT
LIFE-CYCLE COST ANALYSIS SUMMARY

Total Investment	$4,928,020
Energy Discounted Savings	$7,510,137
Non-Energy Discounted Savings	$4,332,335
First Year Dollar Savings	$1,348,383
Simple Payback Period (Years)	3.65
Total Net Discounted Savings	$11,842,470
Savings to Investment Ratio	2.40
Adjusted Internal Rate of Return	12.44%

1.5 DISCUSSION OF RESULTS

The results of the analysis show that for an investment of $4,928,020 Fort Campbell will save $1,348,383 annually with the implementation of the UMCS project. Fort Campbell will recover the investment cost of the project in less than four years.

The UMCS system will give Fort Campbell the capability of having a bird's eye view of its facility and utility systems. This is a very valuable and powerful tool. Through the use of the UMCS/SCADA system, Fort Campbell will be able to manage and operate its facility and utility systems more effectively and efficiently.

1.5.1 Application to HVAC Systems

Heating, ventilating, and air conditioning (HVAC) systems of various facilities can be centrally monitored and controlled. Energy and demand dollars will be saved through temperature setback and scheduled ON and OFF times. The available and easily accessible information will allow Fort Campbell maintenance personnel to implement a more effective preventive maintenance program, reduce service calls, and reduce the overall operations and maintenance costs.

1.5.2 Application to Electrical Systems

The information obtained from electrical load profiles of various feeders, facilities, or individual loads can be used to identify the area of high energy usage concentration and/or possible operation and maintenance problems allowing Fort Campbell to better direct its resources. The electrical demand profile information can be used to coordinate the operation time or sequence of electrical loads in order to limit the electrical demand and save demand dollars. Energy and demand usage data can be automatically retrieved and calculated for billing and accounting purposes, which will save many man-hours and minimize guess work.

1.5.3 Application to Underground Storage Tank Systems

The UMCS/SCADA system is also very effective in the area of hazardous waste management. In this study, the UMCS/SCADA system is utilized to centrally monitor underground storage tanks for fluid levels and for leak detection. The UMCS/SCADA system will reduce the man-hours required to perform on-site monitoring and surveying, and it will also minimize or avoid the costs of cleanup and stiff penalties which would result from a possible leak that could go unnoticed during the non-duty hours.

1.5.4 Application to Other Systems

The SCADA system can also be used to minimize safety hazards by utilizing extensive alarm capabilities for fire detection, security systems, and traffic control monitors.

Perhaps the greatest benefit of the UMCS/SCADA system is that it will help Fort Campbell to manage its response to major accidents, natural disasters, and military threats. The status of the utilities' system can be centrally monitored and controlled, including emergency backup power. The electrical and water system can be isolated and rerouted, as required, for personnel safety and mission operability. The status of critical resources such as water for drinking and fire fighting capability, fuel capacity for missions operability, and electrical utilities for critical facilities can be monitored and managed. This benefit is more than a monetary savings--it also can save lives.

1.6 RECOMMENDATION

In order to fully optimize the benefits of the Utility Monitoring and Control System (UMCS), Systems Corp recommends all of the ECOs in the study be incorporated into a single project. To base the ECOs benefit value solely upon energy savings and tangible monetary return would greatly limit the system's functional capability and defeat the true intent and benefits of the Utility Monitoring and Control System.

2.0 METHODOLOGY

2.1 DATA COLLECTION AND SITE SURVEY

The first phase of the project included collecting general information on the existing EMCS and the overall facility and utility systems at Fort Campbell. The field survey and data collection was performed by a team of four Systems Corp engineers from 23 May to 08 June 1995. Detailed data concerning the existing facility and utility systems were collected from the specific site surveys, manager and operator interviews, record drawings and documentation. Information included system type, mode of operation, energy consumption, maintenance and repair history of equipment, engineering drawings, utility system diagrams, and concerns expressed by operators and managers. Two previous studies were utilized for information purposes only: (1) Operations and Maintenance Manual for Fort Campbell's Water Treatment Plant by O'Brien and Gere Engineers; October 1993. (2) Analysis of Fort Campbell's Electrical Distribution System by Allen and Hoshall Consultants, Inc.; July 1985.

2.2 EXISTING EMCS

The existing EMCS is an antiquated Williams Electric system which has been installed piecemeal over the last ten years. The system consists of a mainframe-type computer unit, Field Interface Device (FID), Multiplexer (MUX), Field Interface Device/Multiplexer (FID/MUX), and Portable Diagnostic Test Unit (PDTU). The system is not compatible with other UMCS or SCADA-type systems without a very large investment. At present the system is in disrepair and is obsolete due to the age of the system components and a lack of system maintenance personnel. During the field survey, the team found that ~~the~~ communication to most of the field interface devices was disabled or disconnected. For these reasons, the analysis considers replacing the existing system, entirely, rather than trying to reuse a part or all of the components. A printout of the existing EMCS system from February 13, 1995, is included in the Field Notes volume. The printout indicates that there is no communication to a majority of the field interface devices; therefore, the system is not effective as an energy management tool.

The Fort also has an existing Frequency Modulated (FM) control system which cycles "OFF" the HVAC condensing units in family housing and other small buildings for approximately seven minutes each hour. This load-shedding scheme is used effectively in seven groups of approximately 200 units each. A separately funded project currently underway will upgrade and expand this system.

The UMCS considered for this analysis incorporates the FM control system as a subsystem for monitoring purposes only; the FM control system will continue to operate as an independent control system.

2.3 FACILITY/UTILITY SYSTEM COMPONENTS

The Study evaluated the economic benefits of utilizing the UMCS/SCADA system to monitor and control Fort Campbell's facility and utility systems. Each system has an associated ECO (Energy Conservation Opportunity) number. The facility and utility systems evaluated under this study are:

ECO 1: HVAC Systems
ECO 2: Electrical Substations
ECO 3: Emergency Generators
ECO 4: Water System
ECO 5: Sewage Treatment System
ECO 6: Remote Metering System
ECO 7: Underground Storage Tanks
ECO 8: Athletic-Field Lights
ECO 9: Traffic Signal Lights

2.4 ANALYSIS

This section details the steps taken in the analysis phase of this project from defining and selecting SCADA system architecture layout to determining the economic benefits and costs of various ECO options. The results of the economic analyses are listed in *Table 2.4.1* and *Table 2.4.2*.

Table 2.4.1

UMCS/SCADA ECOs

LIFE-CYCLE COST ANALYSIS SUMMARY

ECO No.	Investment ($)	Energy Savings (MBtu)	Demand Savings ($)	Non-Energy Savings ($)	Non-Recurring		First Year Savings	Simple Payback	SIR
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9	$154,574	72	$339	$984	0	0	$1,769	87.40	0.10

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UMCS/SCADA OVERALL PROJECT

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Total Net Discounted Savings	$11,842,470
Savings to Investment Ratio	2.40
Adjusted Internal Rate of Return	12.44%

The UMCS/SCADA project as a whole has a simple payback of less than four years and a first year savings more than a million dollars. The project will have a better economic payback if ECO 5: Sewage System, ECO 6: Metering, and ECO 9: Traffic Lights are removed from the project.

However, it is not recommended since these ECOs provide many benefits in terms of the overall operational safety and effectiveness of Fort Campbell. The details of these benefits are outlined in the report.

2.4.1 System Selection

The UMCS/SCADA system selected for study is based on the criteria specified by the Scope of Work and expressed by Fort Campbell personnel at the Entry Meeting. The criteria is defined as follows:

- The system will incorporate up-to-date technology design which will not be obsolete in a few years.
- The system must be user friendly.
- The system must be able to easily integrate with other existing and new systems.
- The system will have a central control, be accessible by multiple work stations and accessible by portable command units (a laptop) to assist central operators.
- The system must be cost effective.
- The system must be reliable.

2.4.2 UMCS/SCADA System Description

SCADA systems consist of several computer stations with appropriate application software connected by communication network systems (wire, radio, power line carrier or fiber optics) to a number of remote terminal units placed at various locations. The terminal units are used to collect data, for remote control, to perform intelligent autonomous (local) control, and to initiate alarm conditions of various facility and utility systems, and to report the information through the communication back to the computer stations.

2.4.3 Network Architecture

2.4.3.1 Overview

The communication system consists of three levels of networks. The highest level is a 60,000-foot fiber optic cable system running Ethernet network software. The fiber optic system's main trunk line runs generally north-south along Kentucky, Tennessee, and Ohio Avenues, the entire length of the Main Post area. Branching off from the main trunk line are nine major zones each controlled by a Langate which communicates to the central control room via the Ethernet network. Each of the nine Langates controls a local network of up to 100 nodes, generally amounting to 40-60 buildings per Langate. See *Figure 2.4.3.1.1* for a schematic diagram of the proposed system. See the attached Ethernet Fiber Optic Network Map in the back pocket of the report.

The local network connects two different types of control modules. The two types of modules are stand-alone control modules and third-party interface modules. The stand-alone modules can control a piece of equipment or a system. If the stand-alone controller loses contact with the network, it will continue to operate based on its last instructions from the network. The third-party interface connects to equipment that already has a digital controller and allows communication with the network. All modules have battery back up that will retain the modules memory until power is restored. Individual modules are connected to the local network by daisy chaining the modules together with twisted pairs of RS485 wire.

In layouts involving remote locations, it is not economically feasible to use fiber optics. For the remote locations FM transceivers are used. The control module of third-party interface modules will be located at the monitoring point with a transceiver and antenna. Another transceiver and antenna will be located at the closest point on the local network. The FM transceiver will allow the remote module to act like any other node on the network.

The network will have human interface at a central control room, where one computer and a file server will be located. Other computers will be located at the water treatment plant, the electrical utilities branch and the HVAC branch of the Department of Public Works. Each computer will have a direct connection to the fiber optic network through an Ethernet card. The operator will have the ability to retrieve information from anywhere on the network. The computers will also have emergency backup power through an uninterruptible power system.

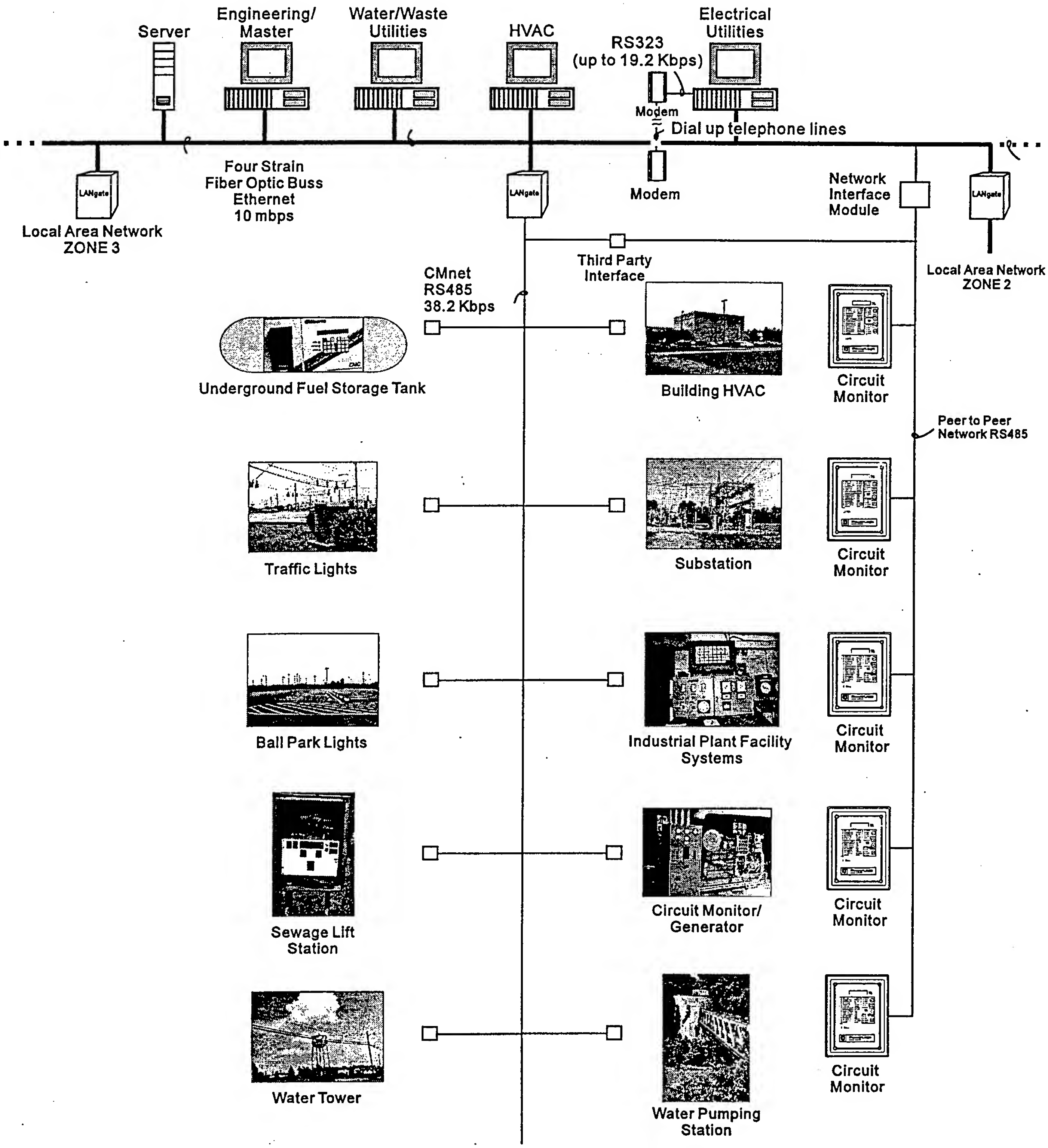


Figure 2.4.3.1.1

UMCS/SCADA SYSTEM APPLICATIONS

2.4.3.2 Fiber Optic System

The fiber optic system used is a single mode system with laser transceivers. Only two-fiber cable is required, but four-fiber cable allows for spares. It is recommended that overhead cable be installed to eliminate the high expenses of underground utility work. Using the existing power pole structure will provide a economical way of installing the fiber cable.

There are two ways to install overhead cable. The first way is to string up messenger or structural wire and then lace non-self supporting fiber cable to the messenger wire. The second method is to use self-supporting cable without messenger wire. Although the self-supporting cable costs more, the total cost is cheaper due to the savings in labor.

Fiber optic systems give two very important advantages over other systems. The first advantage is that fiber optic cable has a very large communication bandwidth (capacity). The transmitter characteristics are the only limit to achieving infinite bandwidth. The very large communication bandwidth also equates to a very fast communication speed, in the order of 10 Mbps, which will give the UMCS a very fast system response time. The second advantage is that the fiber optic communication medium has very low noise and excellent natural immunity to electromagnetic interference (EMI) since it is constructed of non-conductive material.

A fiber optics network will provide the capacity to handle any future communication requirements of the UMCS/SCADA system. In addition, the network will also support other data or voice communication requirements outside the UMCS/SCADA system on the same network since the communication traffic of the UMCS/SCADA system is very low. Thus, installing a new fiber optic network system will save some of the future cost of installing data communication lines.

2.4.3.3 FM Communication

FM communications were looked at very closely for this project. This type of system has the advantage that it is not hard wired; the problems with broken wires or dug up wires would be eliminated. However, there are two disadvantages. First, the system if very susceptible to interference from other radio sources. Secondly, the communication speed is very slow at 4800 bps. After close consideration, the fiber option is recommended for the main system due to the many advantages, including communication reliability, communication speed and large line capacity. However, radio systems should be used on some remote sites.

2.4.3.4 Hardware

2.4.3.4.1 Computer Systems

The central control room will house one computer plus a file server, while the other three computers will be located in different utility operation's offices. Each computer will have direct access to the network through a Ethernet adapter card. The computers are each pentium, 120 megahertz processor with 16 megabytes of ram, 540 megabytes of hard drive, and have a 17-inch color monitor. The file server will be identical except it will have two 1 gigabyte hard drives. The second hard drive will mirror the first and be used as a backup in case of a hard drive failure. The computers will have an emergency backup system provided by an uninterruptible power source.

2.4.3.4.2 Control Modules

Each control module has stand alone capability with on-board processor and memory. In other words, if disconnected from the network the module will continue to operate based on the last instructions from the network. Each control module can be expanded to pick up additional points in the future if necessary. The control modules connect to each other on a local network. The UMCS system, as priced, has only the required number of modules per building to accomplish the proposed work in this project. However, because each module has a fixed number of points, approximately twenty percent expansion capacity is built into the network.

2.4.3.4.3 Third Party Interface Modules

Some existing systems on post have microprocessor controls, such as the traffic light signal. In this case the existing controller will be kept in place and a interface will be used. This gives the capability of talking to the existing controller thought the network. The operators will have the same capability as the stand-alone controller.

Interface modules are also included in the project to interface electrical monitoring equipment onto the network with the rest of the UMCS system. The electrical system can be set up to operate independently on its own software package, or as part of the overall system software package. By connecting the interface module directly onto the network, bypassing the Langate, allows this option of independent network operation. Refer back to *Figure 2.4.3.1.1.*

2.4.3.5 Software

2.4.3.5.1 Controls

The control software will have graphical interface utilizing the Microsoft Windows platform. This gives the operator the ability to do most functions on the system by using only the mouse. Each system on the network will have a dedicated graphics screen that will allow the operator to access any information required and also issue commands to turn equipment on and off.

The system will have the ability to trend any point on the network. The system will have the ability to trend in increments of one second to one hour and store up to a year's data. The operator can display the trend data graphically on the screen or produce a hard copy. Any of the data can be printed out in tabular form and imported into spreadsheet packages. Trend data can be a valuable tool for troubleshooting and doing studies.

The system will be programmed using a graphical programming language. The big advantage of graphical programming over text programming is two-fold. First, the language is easy to learn and use and second, it is self-documenting. The post should have at least two people trained to program on the system. This can be accomplished by a one- to two-week course.

The software is a network application software. A back end or database part of the software will run on the server, and front end software will run on the workstation. This provides a big advantage since the file server only has to process data while the workstation processes the graphics; this gives the system good response time.

2.4.3.5.2 Alarms

One of the most important parts of the software is the handling of alarms. Many systems will report that an alarm has occurred but give the operator little information on the appropriate response to take. With a system as large as Fort Campbell's, an alarm database should be used. This type of database works in conjunction with the control software to provide an almost unlimited amount of information. Not only information like "alarm name" and "location" are given, but also response procedures, troubleshooting guides and design data. For example, if the system reports that a building has high chilled water temperature the operator can report the actual temperature, the design temperature, some

possible causes for the alarm and even fax to maintenance a location map. This type system has been priced into this project.

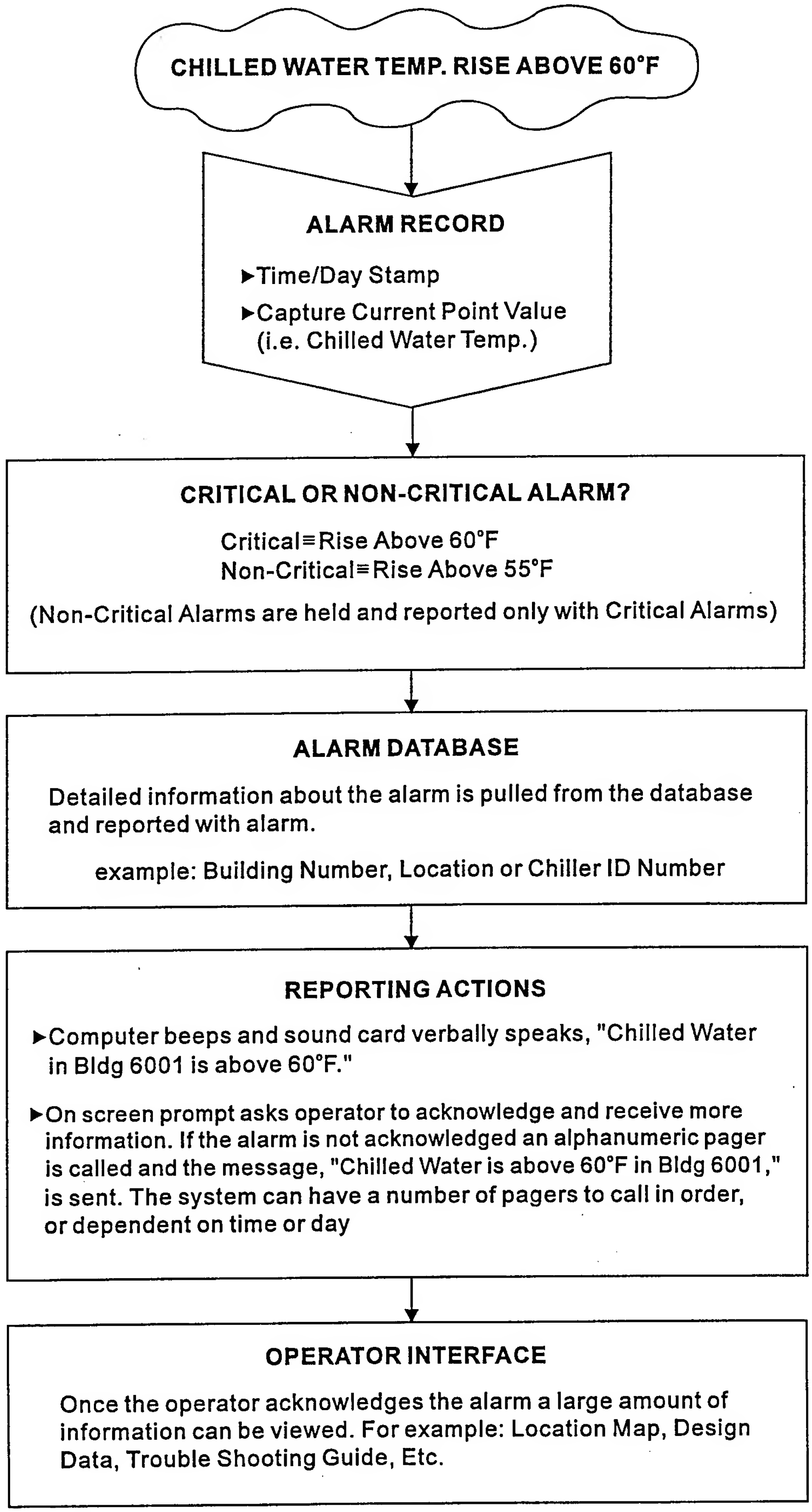
Another important aspect of the system is alarm reporting. The system can be set up to provide audible and visual signals indicating an alarm condition. If the alarm is not acknowledged in a user-defined time period, the system will begin an alarm reporting sequence. This sequence is also user-defined and consists of reporting to remote computers and alphanumeric pagers. The system will continue the sequence until the alarm has been acknowledged. See *Figure 2.4.3.5.2.1* for an alarm logic illustration.

As illustrated above, this software package takes a comprehensive approach in giving the facility's managers the flexibility to define and prioritize alarm and event conditions based on individual building criteria. It also provides them with a sophisticated tracking and reporting capability that is efficient to manage and maintain. The major features which make this software package a truly effective management tool are outlined below:

- ➪ operator defined and prioritized alarms established with an unlimited number of reporting actions.
- ➪ reporting actions automatically triggered by alarms
- ➪ multi-level, password protected access
- ➪ automatic recording of results in action log
- ➪ report delivery options to support printers, remote terminals, pagers, and system commands
- ➪ intelligent operator interface for on screen alarm acknowledgement, viewing of reporting status, access to customized instructions and unique alarm comments
- ➪ remote access for alarm queries and acknowledgement
- ➪ multi-user access to shared database
- ➪ alarm database management utilities for import/export and record deletion

2.4.4 Applications

The UMCS/SCADA system gives Fort Campbell the capability of having a bird's eye view of its facility and utility systems. This is a very valuable and powerful tool. By use of the UMCS/SCADA system Fort Campbell will be able to manage its operations and energy usage more effectively and efficiently. See *Figure 2.4.4.1* on page 2-6 for the overall UMCS/SCADA system applications for Fort Campbell.



EXAMPLE ALARM

Figure 2.4.3.5.2.1

2.4.4.1 HVAC Systems

Heating, ventilating, and air conditioning (HVAC) systems of various facilities can be centrally monitored and controlled. Energy and demand dollars will be saved through temperature setback and scheduled ON and OFF time. The available and easily accessible information will allow Fort Campbell maintenance personnel to implement a more effective preventive maintenance program, reduce service calls, and reduce the overall operations and maintenance costs.

2.4.4.2 Electrical Systems

The information obtained from electrical load profiles of various feeders, facilities, or individual loads can be used to identify the area of high energy usage concentration and or possible operation and maintenance problems allowing Fort Campbell to better direct its resources. Electrical demand profile information can be used to coordinate the operation time or sequence of electrical loads in order to limit the electrical demand and save demand dollars. Energy and demand usage data can be automatically retrieved and calculated for billing and accounting purposes, therefore, saving many man-hours and minimizing guess work.

2.4.4.3 Underground Storage Tank Systems

The UMCS/SCADA system is also very effective in the area of hazardous waste management. In this study, the UMCS/SCADA system is utilized to centrally monitor underground storage tanks for fluid levels and for leak detection. The UMCS/SCADA system will reduce the man-hours required to perform on-site monitoring and surveying, and it will also minimize or avoid the cost of cleanup and stiff penalties from the possible leak that could have gone unnoticed during the non-duty hours.

2.4.4.4 Other Systems

The SCADA system can also be used to minimize safety hazards. The SCADA system can be set up with extensive alarm capabilities for fire detection, security systems, and traffic control monitors.

Perhaps the biggest benefit of the UMCS/SCADA system is that it will help Fort Campbell to manage its response to major accidents, natural disasters, and military threats. The status of the utilities' system can be centrally monitored and controlled, including emergency backup power. The electrical and water system can be isolated and rerouted as required for personnel safety and mission operability.

The status of critical resources such as water for drinking and fire fighting capability, fuel capacity for missions operability, and electrical utilities for critical facilities can be monitored and managed. This benefit is more than a monetary savings; it also can save lives.

3.1 SYSTEM DESCRIPTIONS AND APPLICATION METHODS

The applications considered in HVAC systems for a new Utility Monitoring and Control System (UMCS) include all facilities which are connected to the existing EMCS. Other facilities were considered only where the HVAC systems were large enough to generate energy savings sufficient to justify the initial investment cost. Applications beyond the buildings currently on the EMCS are limited, since most of the remaining facilities are World War II-era wood structures which typically have no central heating and air-conditioning systems.

The buildings considered for this ECO fall into the categories listed below:

(1)	Barracks	ECO 1A
(2)	Administration/Offices	ECO 1B
(3)	Hangars	ECO 1C
(4)	Dining Facilities/Clubs	ECO 1D
(5)	Gyms/Recreational Facilities	ECO 1E
(6)	Central Plants	ECO 1F
(7)	Miscellaneous	ECO 1G

The seven categories were determined primarily by building occupancy and load patterns; and to a lesser extent, the type and size of the HVAC system present in each building. Throughout the remainder of this report, ECO 1 will refer to the application of UMCS to all seven types of buildings. UMCS application within each of the seven building types will be classified as ECO 1A, ECO 1B, etc.

In cases where up-to-date and accurate information regarding HVAC systems were not readily available, Systems Corp relied on information from previous studies, original equipment manufacturers' data and opinions, and rule-of-thumb standards as set forth in industry accepted publications such as the *American Society of Heating, Refrigeration and Air-Conditioning Engineers* (ASHRAE)*Handbooks*.

Previous studies from which pertinent system information was gathered include the following:

⇨ Energy Savings Opportunity Survey - Phase I, Energy Engineering Analysis Program; Fort Campbell, Ky; November 1993, contract #DACA 27-93-C-0096.

⇨ Energy Savings Opportunity Survey - Phase II, Energy Engineering Analysis Program; Fort Campbell, Ky; November 1993, contract #DACA 27-93-C-0096.

Section 3.2, Page 3-24, details the economic analysis process for this ECO. Calculations, cost estimates and life-cycle cost analyses for this ECO are found in *Appendix C*. A description of UMCS points applied under this ECO is also found in *Appendix C*.

3.1.1 ECO 1A: Barracks

The barracks considered for this ECO were primarily of two types: the older hammerhead-style barracks located mainly in the 3200, 6700 and 6900 blocks; and the newer barracks in the 3700 and 4000 areas. All of the barracks are heated and cooled by individual room two-pipe fan coil units, which are not currently on the EMCS. The fan-coil units were not considered for the new UMCS installation, as the energy use per control point required is very low. An attractive simple payback is more likely achieved by controlling the operating hours of the dual temperature (DT) pumps which provide hot and chilled water to the fan-coil units within each barracks. The typical barracks contains one 7.5 horsepower pump which operates year round. By installing a local panel with a total of five inputs and outputs in each building, each barrack's DT pump is cycled on and off during unoccupied hours. The pumps are cycled based on the space temperature. The building space temperature is determined by averaging the temperature at six locations (two on each floor). If one of the temperature readings is determined to be skewed, the average building temperature will be calculated using the other five readings. This method accomplishes the same energy savings at a fraction of the cost of controlling individual fan coil units. In addition to saving energy by contouring building set points, demand savings can be achieved by cycling the pumps in a controlled manner. Authorized building managers and EMCS operators have the ability to override the programmed schedule, either locally or at the central control room.

Barracks in the 3700 and 4000 blocks have a single air handler which provides outside air to each building. These air handlers are shut "off" to provide outside air reduction savings. The barracks in the 700 and 6900 blocks contain four general exhaust fans in each building which provide an inflow of outside air when they are activated. In these barracks, the exhaust fans are cycled "off" during unoccupied hours to achieve outside air reduction savings.

The barracks in the 3700 and 4000 areas are served by central plant 3902 for both steam and chilled water. However, nine of the barracks located in the 6700 and 6900 blocks contain steam absorption chillers which serve the surrounding barracks and administrative buildings. Each of these chillers requires an additional five control points, bringing the total number to ten points. Still utilizing one control module, these additional points allow the chilled water temperature to be reset for greater natural gas energy savings. Refer to *Figure 3.1.1.1* for a typical barracks system configuration. *Table 3.1.1.1* lists the buildings considered for this ECO, the number of control points required per building, and costs and savings used in the analysis. See *Table 3.1.1.2* for the savings/costs summary for ECO 1A. Calculations, cost estimates and life-cycle cost analyses for this ECO are found in *Appendix C*.

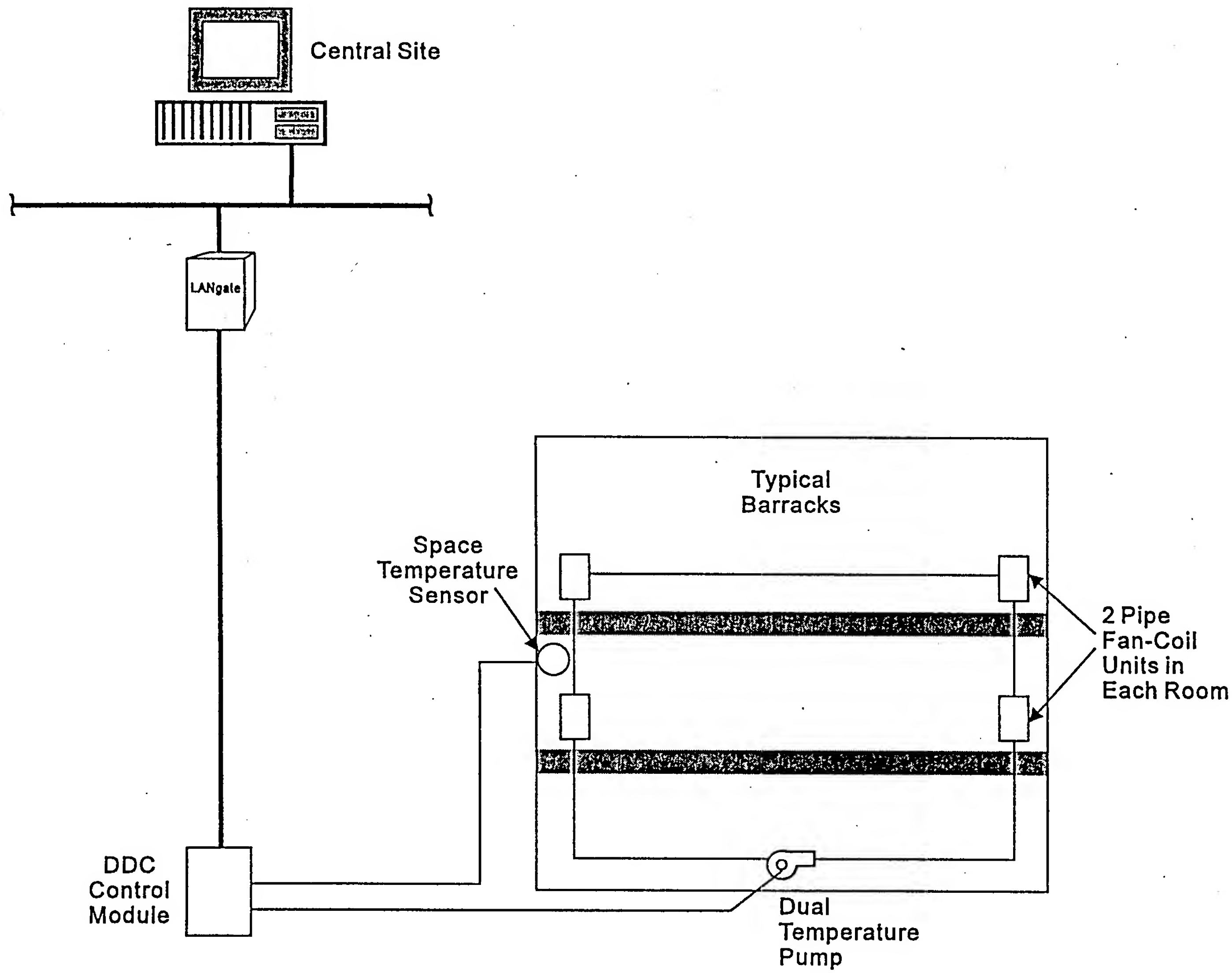


Figure 3.1.1.1

TYPICAL BARRACKS SYSTEM CONFIGURATION

Table 3.1.1.1

ECO 1A - HVAC - BARRACKS: COSTS/SAVINGS

Bldg	Points*	Instal. Cost/Point	Total Cost	Maint Savings	Energy Savings		Demand Savings
					Nat Gas	Electric	
3211	5	$885	$6,685	$0	$2,323	$0	$190
3212	5	$885	$6,685	$0	$2,326	$0	$190
3213	5	$885	$6,685	$0	$3,651	$0	$190
3214	5	$885	$6,685	$0	$4,612	$0	$190
3215	5	$885	$6,685	$0	$2,328	$0	$190
3216	5	$885	$6,685	$0	$2,328	$0	$190
3217	5	$885	$6,685	$0	$2,323	$0	$190
3218	5	$885	$6,685	$0	$2,323	$0	$190
3713	5	$885	$6,685	$0	$1,274	$273	$190
3725	5	$885	$6,685	$0	$1,274	$273	$190
3730	5	$885	$6,685	$0	$986	$212	$190
3731	5	$885	$6,685	$0	$990	$213	$190
3748	5	$885	$6,685	$0	$986	$212	$190
3750	5	$885	$6,685	$0	$986	$212	$190
3754	5	$885	$6,685	$0	$991	$213	$190
3766	5	$885	$6,685	$0	$1,272	$273	$190
4024	5	$885	$6,685	$0	$986	$212	$190
4028	5	$885	$6,685	$0	$986	$212	$190
4033	5	$885	$6,685	$0	$986	$212	$190
4038	5	$885	$6,685	$0	$1,274	$273	$190
4039	5	$885	$6,685	$0	$986	$212	$190
4044	5	$885	$6,685	$0	$986	$212	$190
4053	5	$885	$6,685	$0	$691	$150	$190
4057	5	$885	$6,685	$0	$986	$212	$190
4067	5	$885	$6,685	$0	$1,272	$273	$190
6725	5	$885	$6,685	$0	$2,247	$0	$190
6726	10	$600	$8,260	$0	$5,322	$0	$190
6727	5	$885	$6,685	$0	$2,250	$0	$190
6730	5	$885	$6,685	$0	$2,241	$0	$190
6731	5	$885	$6,685	$0	$2,245	$0	$190
6732	10	$600	$8,260	$0	$4,823	$0	$190
6733	5	$885	$6,685	$0	$2,233	$0	$190
6774	10	$600	$8,260	$0	$2,689	$0	$190
6775	5	$885	$6,685	$0	$2,241	$0	$190
6776	10	$600	$8,260	$0	$4,979	$0	$190
6777	5	$885	$6,685	$0	$2,247	$0	$190

Table 3.1.1.1

ECO 1A - HVAC - BARRACKS: COSTS/SAVINGS

Bldg	Points*	Instal. Cost/Point	Total Cost	Maint Savings	Energy Savings		Demand Savings
					Nat Gas	Electric	
6778	5	$885	$6,685	$0	$2,244	$0	$190
6779	5	$885	$6,685	$0	$2,323	$0	$190
6780	5	$885	$6,685	$0	$2,323	$0	$190
6781	10	$600	$8,260	$0	$4,966	$0	$190
6782	5	$885	$6,685	$0	$2,241	$0	$190
6783	5	$885	$6,685	$0	$1,907	$0	$190
6912	5	$885	$6,685	$0	$2,250	$0	$190
6918	5	$885	$6,685	$0	$2,268	$0	$190
6919	5	$885	$6,685	$0	$2,271	$0	$190
6920	5	$885	$6,685	$0	$2,268	$0	$190
6921	5	$885	$6,685	$0	$2,258	$0	$190
6922	5	$885	$6,685	$0	$2,270	$0	$190
6923	5	$885	$6,685	$0	$2,258	$0	$190
6927	5	$885	$6,685	$0	$2,240	$0	$190
6928	5	$885	$6,685	$0	$2,241	$0	$190
6929	10	$600	$8,260	$0	$4,986	$0	$190
6930	5	$885	$6,685	$0	$2,244	$0	$190
6931	5	$885	$6,685	$0	$1,906	$0	$190
6936	10	$600	$8,260	$0	$3,276	$0	$190
6937	5	$885	$6,685	$0	$2,229	$0	$190
6938	10	$600	$8,260	$0	$4,973	$0	$190
6939	5	$885	$6,685	$0	$2,241	$0	$190
6940	5	$885	$6,685	$0	$2,241	$0	$190
6942	5	$885	$6,685	$0	$2,239	$0	$190
6943	5	$885	$6,685	$0	$2,237	$0	$190
6944	10	$600	$8,260	$0	$5,489	$0	$190
6945	5	$885	$6,685	$0	$1,905	$0	$190
7110	5	$885	$6,685	$0	$734	$159	$190
7112	5	$885	$6,685	$0	$788	$171	$190
7118	5	$885	$6,685	$0	$788	$171	$190
7120	5	$885	$6,685	$0	$788	$171	$190

*For a description of control points, see *Appendix C.*

Table 3.1.1.2

ECO 1A - HVAC - BARRACKS: COSTS/SAVINGS SUMMARY

Construction Cost (see cost estimate in Appendix C)	$462,070
Annual Energy /Savings / Costs	
Electrical Energy (MBtu/Yr)	730
Electrical Demand ($/Yr)	$12,718
Thermal Energy (MBtu/Yr)	
Natural Gas (MBtu/Yr)	34,261
Fuel Oil	
Non-Energy Savings / Costs Operation / Maintenance ($/Yr)	$0
Non-Recurring Savings / Costs	$155,325

3.1.2 ECO 1B: Administration/Offices

Most of the buildings considered for this ECO were located in the same areas as the barracks described in ECO 1A. The newer buildings in the 3700 to 4000 blocks are served by central plant 3902 for both steam and chilled water, and the older office buildings located among the hammer-head barracks of the 6700 and 6900 blocks are served by the semi-centralized natural gas absorption chillers and boilers located within a few of the barracks in the area. In this older area the HVAC systems are similar to the systems in the barracks. That is, they are heated and cooled by individual room two-pipe fan coil units, which are not currently on the EMCS. The fan-coil units were not considered for the new UMCS installation, as the energy use per control point required is very low and an attractive simple payback is more likely achieved by controlling the operating hours of the dual temperature pumps which provide hot and chilled water to the fan-coil units within each room. By installing a local control panel with a total of five inputs and outputs in each building, each building's DT pump is cycled on and off during unoccupied hours. The pump's cycle is based on supply and return water temperature, as long as the space temperature is satisfied. The space temperature is determined by averaging the temperature at various locations on each floor. The temperature of at least three points will be monitored. This method accomplishes the same energy savings at a fraction of the cost of controlling individual fan coil units. Authorized building monitors and EMCS operators have the ability to override the programmed schedule, either locally or at the central control room.

Three of the office buildings located in the 6700 and 6900 blocks contain steam absorption chillers which serve the surrounding barracks and administrative buildings. Each of these chillers requires an additional five control points, bringing the total number to ten points in these three buildings only. Still, utilizing one control module, these additional points allow the chilled water temperature to be reset for greater natural gas energy savings.

The office buildings in the 3700 and 4000 areas contain central air handlers instead of fan coil units, so additional control points for these units are required. Refer to *Figure 3.1.2.1* for a typical administration/office system configuration. *Table 3.1.2.1* lists the buildings considered for this ECO, the number of control points required per building, and costs and savings used in the analysis. See *Table 3.1.2.2* for the savings/costs summary for ECO 1B.

Calculations, cost estimates and life-cycle cost analyses for this ECO are found in *Appendix C.*

3.1.3 ECO 1C: Hangars

Ten buildings were considered for this ECO, all located in the area of the Army Airfield. Approximately one quarter of the square footage of each hangar is office space while the remaining area is high-bay hangar space. The high-bay spaces are served by multiple small hot water heating and ventilating units and unit heaters.

The office areas of the hangar buildings are served by a single central station air handler with a direct-expansion (DX) cooling coil and a hot water heating coil. By installing a local control panel with 45 to 90 total inputs and outputs in each building, each building's air handlers are cycled on and off during unoccupied hours. The units cycle based on the space temperature, which is set up to 82 degrees in the cooling season and set back to 57 in the heating season. Authorized building monitors and EMCS operators have the ability to override the programmed schedule, either locally or at the central control room. Refer to *Figure 3.1.3.1* for a typical hangar system configuration. *Table 3.1.3.1* lists the buildings considered for this ECO, the number of control points required per building, costs and savings used in the analysis. See *Table 3.1.3.2* for the savings/costs summary for ECO 1C.

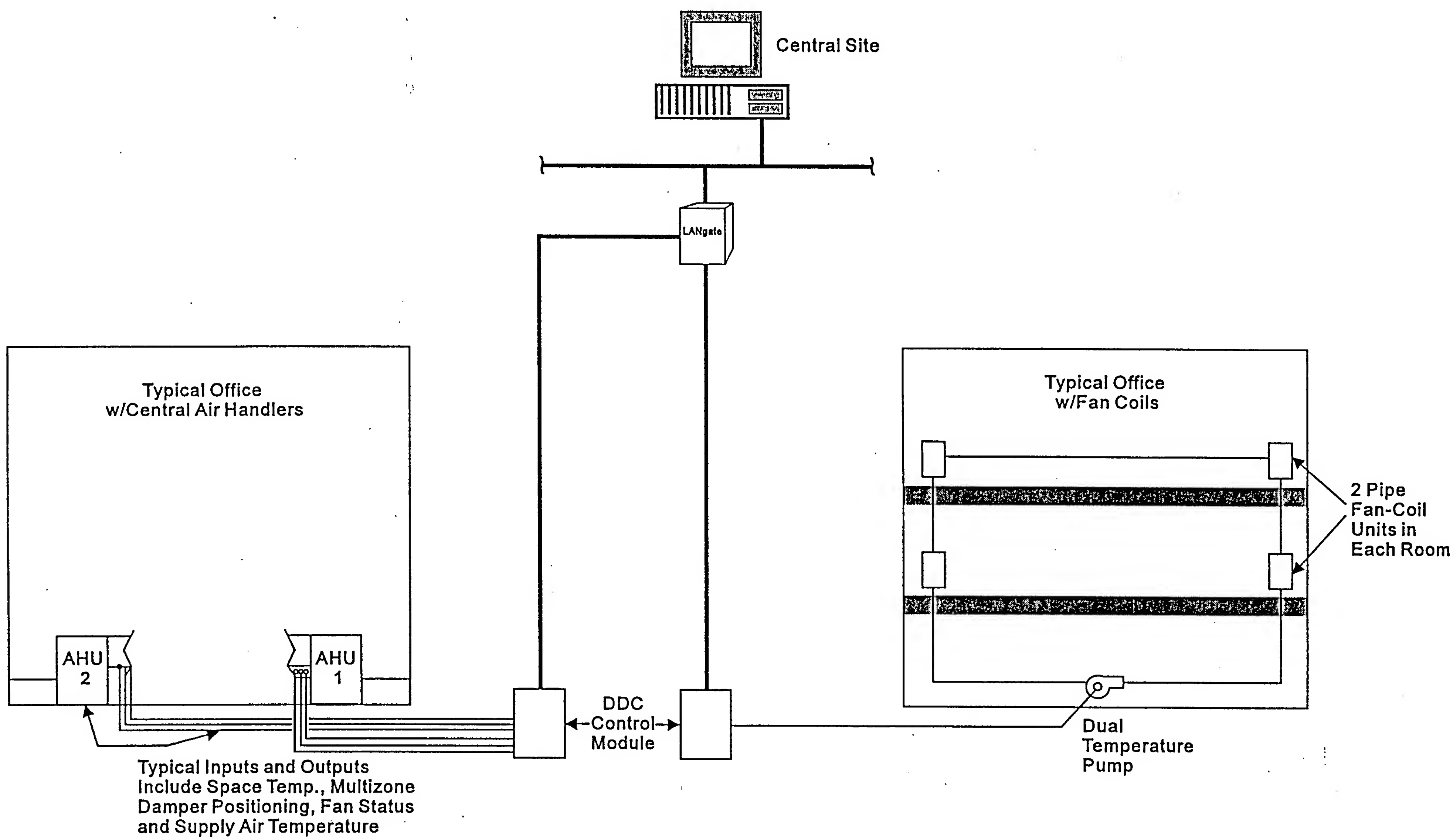


Figure 3.1.2.1

TYPICAL OFFICE SYSTEM CONFIGURATIONS

Table 3.1.2. 1

ECO 1B - HVAC - ADMINISTRATIVE BUILDINGS: COSTS/SAVINGS

Bldg.	Points*	Instal. Cost/Point	Total Cost	Maint. Savings	Energy Savings		Demand Savings
					Natural Gas	Electricity	
3672	100	$378	$40,060	$1,600	$2,816	$134	$195
3680	60	$405	$26,560	$960	$1,742	$84	$195
3686	60	$405	$26,560	$960	$1,742	$84	$195
3755	60	$405	$26,560	$960	$1,742	$84	$195
3759	60	$405	$26,560	$960	$1,742	$84	$195
3763	20	$491	$12,080	$640	$1,377	$67	$195
3767	80	$378	$32,500	$1,280	$2,281	$109	$195
3780	20	$491	$12,080	$320	$1,158	$57	$195
3962	20	$491	$12,080	$320	$1,158	$57	$195
4013	20	$491	$12,080	$320	$628	$31	$195
4017	20	$491	$12,080	$320	$628	$31	$195
4021	20	$491	$12,080	$320	$724	$36	$195
4025	20	$491	$12,080	$320	$753	$38	$195
4029	100	$378	$40,060	$1,600	$2,281	$109	$195
4054	100	$378	$40,060	$1,600	$2,816	$134	$195
4062	60	$405	$26,560	$960	$1,742	$84	$195
4068	60	$405	$26,560	$960	$1,742	$84	$195
5661	30	$491	$16,990	$480	$2,521	$120	$195
5740	30	$491	$16,990	$480	$1,816	$94	$195
6254	5	$885	$6,685	$0	$1,406	$79	$195
6390	20	$491	$12,080	$320	$1,479	$72	$195
6709	5	$885	$6,685	$0	$5,781	$0	$195
6710	5	$885	$6,685	$0	$5,817	$0	$195
6711	10	$600	$8,260	$0	$8,885	$0	$195
6712	5	$885	$6,685	$0	$5,800	$0	$195
6715	5	$885	$6,685	$0	$2,834	$0	$195
6718	10	$600	$8,260	$0	$5,761	$0	$195
6719	5	$885	$6,685	$0	$4,551	$0	$195
6728	5	$885	$6,685	$0	$5,800	$0	$195
6901	5	$885	$6,685	$0	$1,705	$0	$195
6909	5	$885	$6,685	$0	$4,908	$0	$195
6910	10	$600	$8,260	$0	$8,511	$0	$195
$4,966	5	$885	$6,685	$0	$5,790	$0	$195
$2,229	5	$885	$6,685	$0	$556	$0	$195
$2,241	5	$885	$6,685	$0	$5,827	$0	$195

Table 3.1.2.2

ECO 1B - HVAC - ADMINISTRATIVE BUILDINGS: COSTS/SAVINGS SUMMARY

Construction Cost (see cost estimate in Appendix C)	$547,660
Annual Energy /Savings / Costs	
Electrical Energy (MBtu/Yr)	270
Electrical Demand ($/Yr)	$6,833
Thermal Energy (MBtu/Yr)	
Natural Gas (MBtu/Yr)	24,556
Fuel Oil	$0
Non-Energy Savings / Costs Operation / Maintenance ($/Yr)	$15,680
Non-Recurring Savings / Costs	$234,280

Table 3.1.3.1

ECO 1C - HANGARS: COSTS/SAVINGS

Bldg.	Points*	Instal Cost/Point	Total Cost	Maint Savings	Energy Savings Natural Gas	Energy Savings Electricity	Demand Savings
6628	89	$378	$35,902	$400	$3,367	$102	$0
7206	45	$491	$24,355	$400	$1,372	$41	$0
7208	45	$491	$24,355	$400	$2,119	$64	$0
7210	45	$491	$24,355	$400	$1,805	$54	$0
7214	60	$405	$26,560	$400	$2,274	$68	$0
7218	60	$405	$26,560	$400	$2,274	$68	$0
7245	60	$405	$26,560	$400	$2,640	$79	$0
7249	60	$405	$26,560	$400	$2,652	$80	$0
7251	60	$405	$26,560	$400	$2,236	$67	$0
7264	89	$378	$35,902	$400	$3,183	$96	$0

*For a description of control points, see *Appendix C.*

Calculations, cost estimates and life-cycle cost analyses for this ECO are found in *Appendix C.*

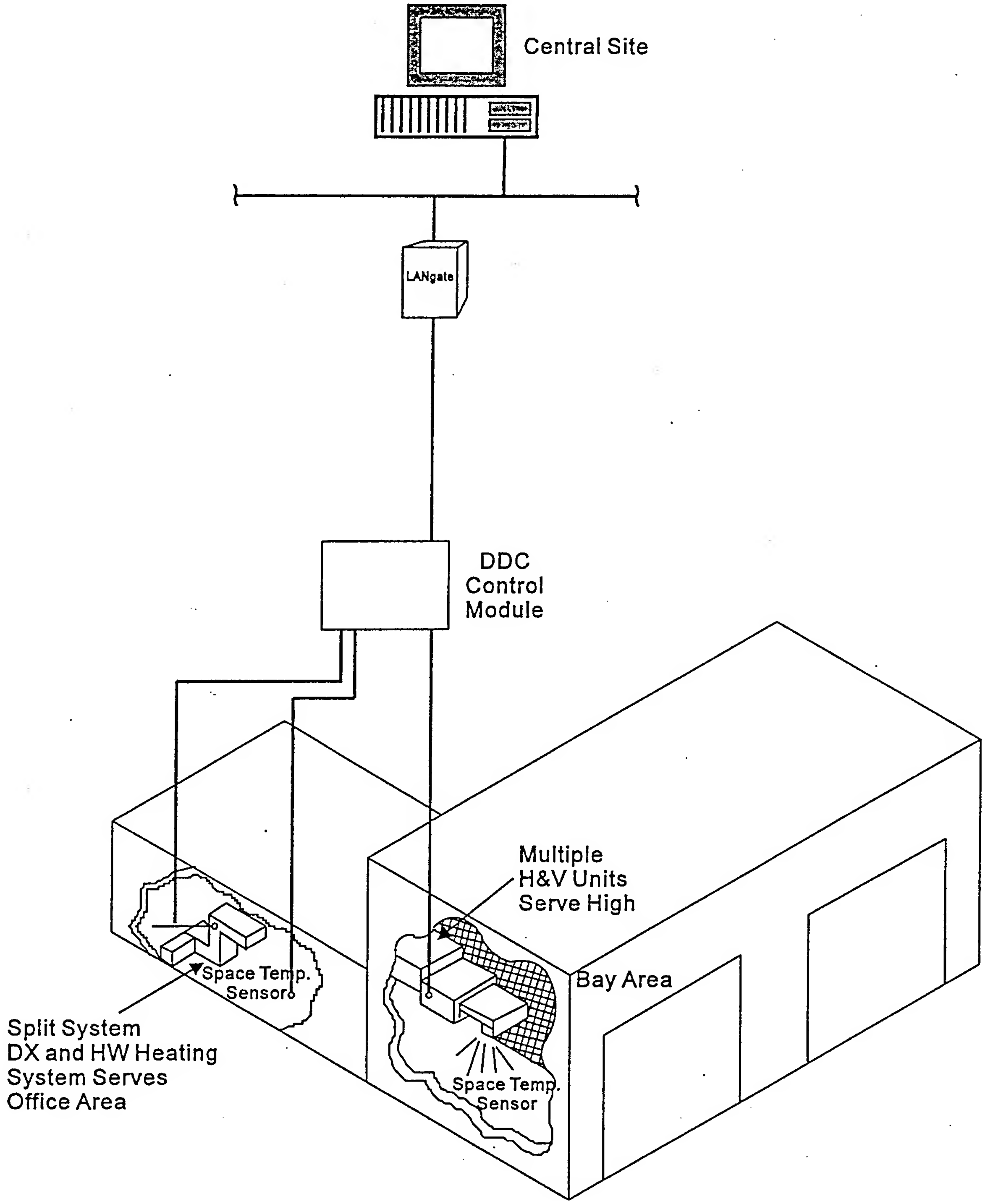


Figure 3.1.3.1

TYPICAL HANGAR SYSTEM CONFIGURATION

Table 3.1.3.2

ECO 1C - HANGARS: COSTS/SAVINGS SUMMARY

Construction Cost (see cost estimate in Appendix C)	$277,699
Annual Energy /Savings / Costs	
Electrical Energy (MBtu/Yr)	116
Electrical Demand ($/Yr)	$0
Thermal Energy (MBtu/Yr)	
Natural Gas (MBtu/Yr)	5,499
Fuel Oil	- 0 -
Non-Energy Savings / Costs Operation / Maintenance ($/Yr)	$4,000
Non-Recurring Savings / Costs	$127,535

3.1.4 ECO 1D: Dining Facilities/Clubs

Six buildings were considered for this ECO: the Officer's Club, the NCO Club and four troop dining facilities. The dining facilities are in the 3700 to 4000 blocks and are served by central plant 3902 for both steam and chilled water. The two clubs are served by their own air-cooled chillers and steam boilers. All buildings utilize centralized air handling units for air distribution and contain a number of exhaust hoods and fans which can be connected to the UMCS, as well as chilled and hot water pumps which operate year round.

By installing a local panel with a total of forty-five points in each dining facility and ninety points in each club, air handlers can be cycled on and off during unoccupied hours to achieve energy savings, and chillers and boilers can be monitored for maintenance savings. The air-handling units cycle based on the space temperature, which8 is set up to 82 degrees in the cooling season and set back to 57 degrees in the heating season. Authorized building monitors and EMCS operators will have the ability to override the programmed schedule, either locally or from the central control room.

Refer to *Figure 3.1.4.1* for a typical dining facility system configuration. *Table 3.1.4.1* lists the buildings considered for this ECO, the number of control points required per building, costs and

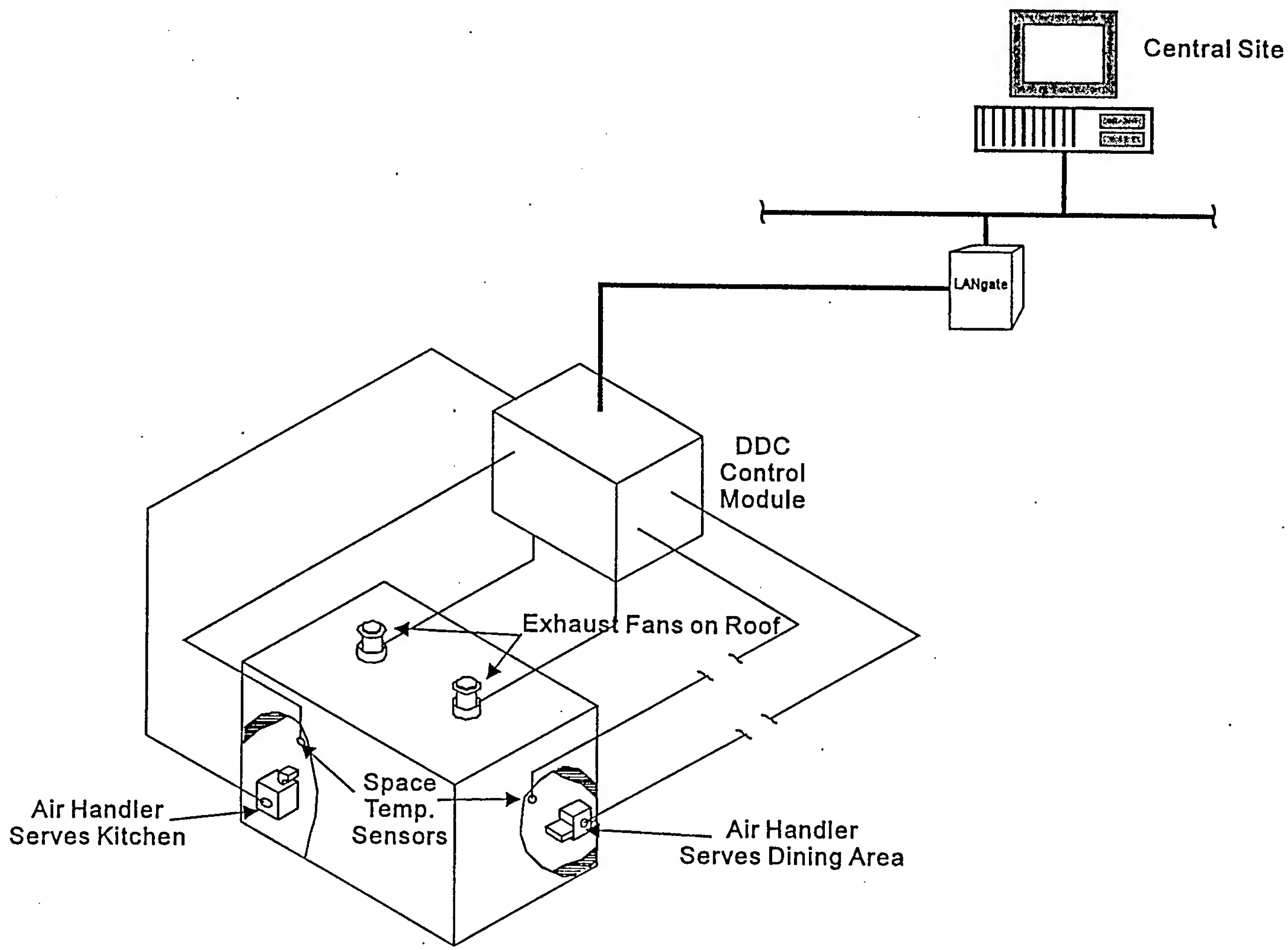


Figure 3.1.4.1

TYPICAL DINING FACILITY SYSTEM CONFIGURATION

Table 3.1.4.1

ECO 1D - DINING FACILITIES/CLUBS: COSTS/SAVINGS

Bldg	Points*	Instal Cost/Point	Total Cost	Maint Savings	Energy Savings		Demand Savings
					Natural Gas	Electricity	
1501	90	$405	$38,710	$1,280	$3,977	$96	$0
2577	90	$405	$38,710	$1,280	$2,527	$77	$0
3717	45	$491	$24,355	$640	$869	$28	$0
3721	30	$491	$16,990	$320	$439	$15	$0
3910	45	$491	$24,355	$640	$1,009	$32	$0
4061	45	$491	$24,355	$640	$1,002	$32	$0

*For a description of control points, see *Appendix C.*

savings used in the analysis. Calculations, cost estimates and life-cycle cost analyses for this ECO are found in *Appendix C.* See *Table 3.1.4.2* for the savings/costs summary for ECO 1D.

Table 3.1.4.2

ECO 1D - DINING FACILITIES/CLUBS: COSTS/SAVINGS SUMMARY

Construction Cost (see cost estimate in Appendix C)	$167,475
Annual Energy / Savings / Costs	
Electrical Energy (MBtu/Yr)	45
Electrical Demand ($/Yr)	$0
Thermal Energy (MBtu/Yr)	
Natural Gas (MBtu/Yr)	2,258
Fuel Oil	
Non-Energy Savings / Costs Operation / Maintenance ($/Yr)	$4,800
Non-Recurring Savings / Costs	$76,958

3.1.5 ECO 1E: Gyms/Recreation Facilities

Eight buildings were considered for this ECO, most located near the barracks areas described in ECO 1A. All facilities are served by two heating and ventilating units in the gym area and two multizone DX units serving the remaining areas. Each facility has its own boiler and air-cooled condensing unit which will be connected to the UMCS.

By installing a local panel with a total of twenty points in each facility, air handlers can be cycled on and off during unoccupied hours to achieve energy savings, and condensing units and boilers can be monitored for maintenance savings. The air-handling units cycle based on the space temperature, which is set up to 82 degrees in the cooling season and set back to 57 degrees in the heating season. Authorized building monitors and EMCS operators will have the ability to override the programmed schedule, either locally or from the central control room.

Refer to *Figure 3.1.5.1* for a typical gymnasium system configuration. *Table 3.1.5.1* lists the buildings considered for this ECO, the number of control points required per building, costs and savings used in the analysis. Calculations, cost estimates and life-cycle cost analyses for this ECO are found in *Appendix C*. See *Table 3.1.5.2* for the savings/costs summary for ECO 1E.

Table 3.1.5.1
ECO 1E - HVAC - GYMS/RECREATION CENTERS: COSTS/SAVINGS

Bldg.	Points*	Instal. Cost/Point	Total Cost	Maint Savings	Energy Savings		Demand Savings
					Natural Gas	Electricity	
2270	20	$491	$12,080	$320	$932	$10	$0
3411	20	$491	$12,080	$320	$1,068	$12	$0
3610	20	$491	$12,080	$320	$1,255	$12	$0
3932	20	$491	$12,080	$320	$1,053	$12	$0
6145	20	$491	$12,080	$320	$1,190	$13	$0
6990	20	$491	$12,080	$320	$1,053	$12	$0
6992	20	$491	$12,080	$320	$1,053	$12	$0
7540	20.	$491	$12,080	$320	$610	$7	$0

*For a description of control points, see *Appendix C*.

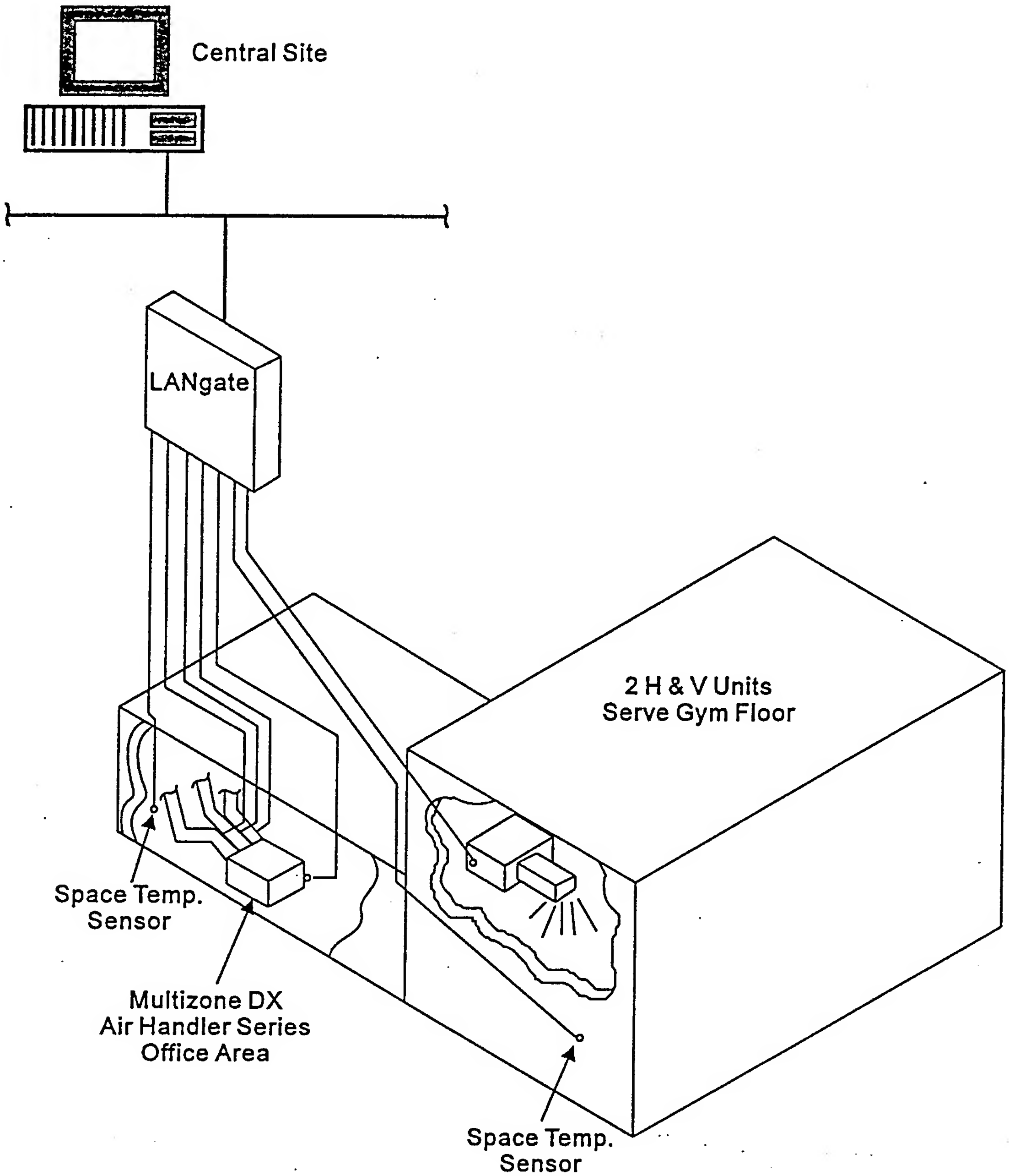


Figure 3.1.5.1

TYPICAL GYMNASIUM SYSTEM CONFIGURATION

Table 3.1.5.2

ECO 1E - HVAC - GYMS/RECREATION CENTERS: COSTS/SAVINGS SUMMARY

Construction Cost (see cost estimate in Appendix C)	$96,640
Annual Energy /Savings / Costs	
Electrical Energy (MBtu/Yr)	15
Electrical Demand ($/Yr)	$0
Thermal Energy (MBtu/Yr)	
Natural Gas (MBtu/Yr)	1,888
Fuel Oil	
Non-Energy Savings / Costs Operation / Maintenance ($/Yr)	$1,920
Non-Recurring Savings / Costs	$29,460

3.1.6 ECO 1F: Central Plants

Six facilities were analyzed for this ECO. Buildings 157, 858, 7008 and 7223 are boiler plants supplying steam to a number of facilities in their respective areas. These boilers will be monitored for steam flow; flue gas temperature, carbon dioxide content, oxygen content and combustion efficiency. By monitoring these variables closely and accurately and taking proper corrective action, the boilers' efficiencies can be maintained approximately 3 percent higher year round than existing conditions allow.

Building 6921A is a chiller plant serving a block of buildings in the hammer-head barracks area. The building contains a natural gas absorption chiller which would be connected to the new UMCS for resetting chilled water supply temperature based on return chilled water temperature. Other variables such as steam pressure and flow are monitored for maintenance savings.

Building 3902 houses the largest central chiller and steam plant on the Post. The plant contains three 15,000 pounds per hour steam boilers, and three 800-ton centrifugal chillers, a number of large pumps and two 15 horsepower air compressors, all of which will be connected to the proposed UMCS. The

boilers are monitored for all of the same variables as in the other four plants, with the same 3 percent efficiency increase expected. Energy savings are attained by resetting chilled water temperature and operational savings are achieved by monitoring the chillers, just as in the other chiller plants.

Refer to *Figure 3.1.6.1* for a typical central plant system configuration. *Table 3.1.6.1* lists the buildings considered for this ECO, the number of control points required per building, costs and savings used in the analysis. Calculations, cost estimates and life-cycle cost analyses for this ECO are found in *Appendix C*. See *Table 3.1.6.2* for the savings/costs sum0mary for ECO 1F.

TABLE 3.1.6.1

ECO 1F - CENTRAL PLANTS: COSTS/SAVINGS

Bldg.	Points*	Instal. Cost/Point	Total Cost	Maint Savings	Energy Savings		Demand Savings
					Nat Gas	Elect.	
157	80	405	$34,660	$2,400	$5,721	$0	$0
858	30	491	$16,990	$1,600	$5,721	$0	$0
3902	70	405	$30,610	$4,800	$12,164	$5,200	$0
6921A	10	600	$8,260	$800	$4,876	$0	$0
7008	30	491	$16,990	$1,600	$5,721	$0	$0
7223	30	491	$16,990	$1,600	$5,721	$0	$0

*For a description of control points, see *Appendix C*.

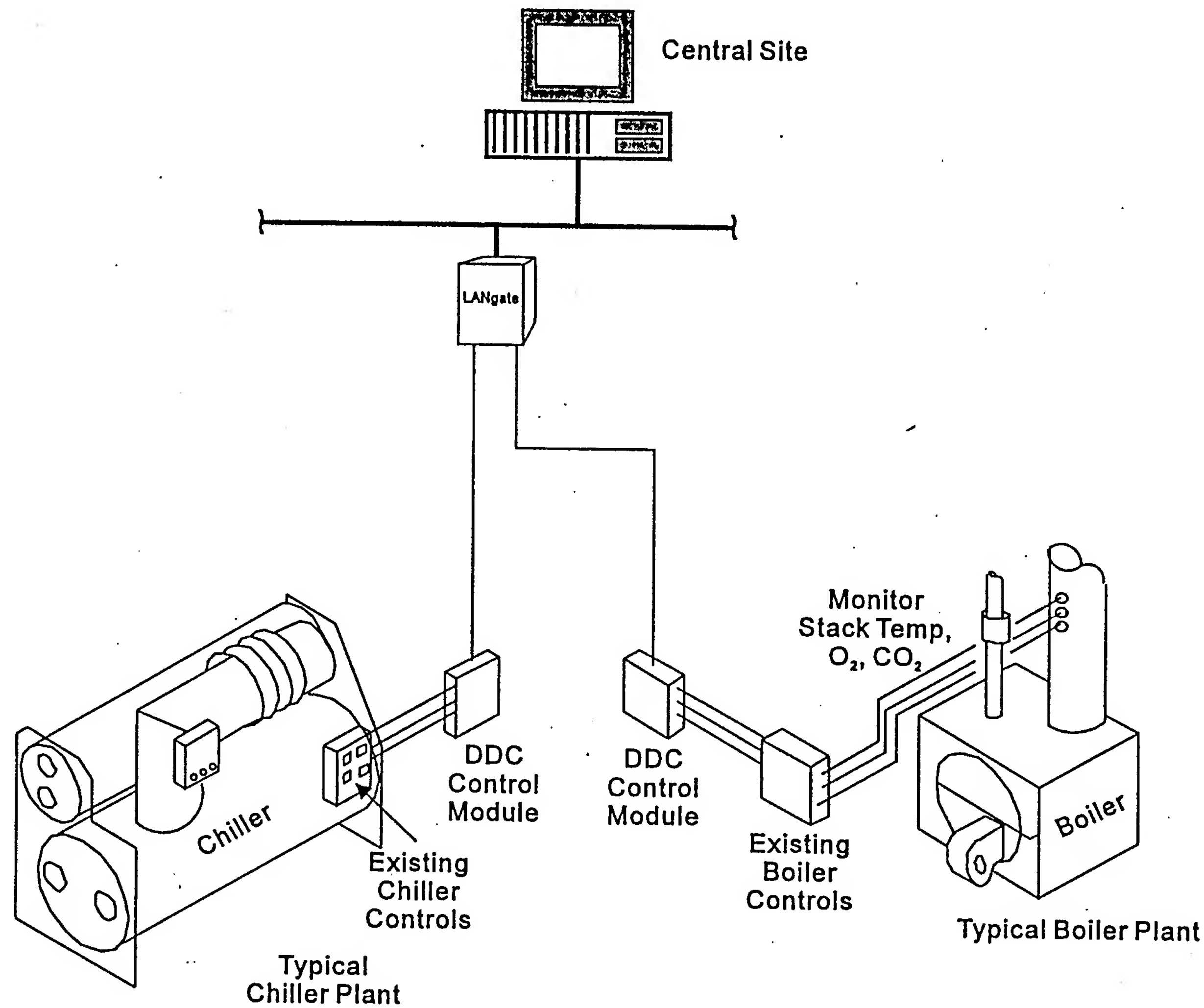


Figure 3.1.6.1

TYPICAL CENTRAL PLANT SYSTEM CONFIGURATION

Table 3.1.6.2

ECO 1F - CENTRAL PLANTS: COSTS/SAVINGS SUMMARY

Construction Cost (see cost estimate in Appendix C)	$124,500
Annual Energy /Savings / Costs	
Electrical Energy (MBtu/Yr)	840
Electrical Demand ($/Yr)	
Thermal Energy (MBtu/Yr)	
Natural Gas (MBtu/Yr)	9,170
Fuel Oil	$0
Non-Energy Savings / Costs Operation / Maintenance ($/Yr)	$12,800
Non-Recurring Savings / Costs	$55,470

3.1.7 ECO 1G: Miscellaneous Buildings

This ECO encompasses buildings that could not easily be placed in any of the preceding six categories. Some of the buildings include: the Post Library, Theater, Commissary, PX, Post Office, bowling centers, dental clinics, and chapels. Most of the buildings considered for this ECO were located nearby other buildings evaluated for UMCS hookup, so as to minimize costs associated with communications wiring.

The facilities in this grouping are served by individual boilers and cooling systems which are connected to the proposed UMCS for temperature resets and monitoring for maintenance purposes. Additionally, the flight simulator buildings 6551, 6555, 6559, and 6563 were surveyed for monitoring purposes only by the SCADA system. At the request of LINK simulator building operators, no setbacks or shutoffs were employed in these facilities due to the precise humidity and temperature requirements of the simulation equipment, as well as the potential expense of equipment damage due to moisture buildup during HVAC equipment shutdowns.

Similar to the preceding ECO's, the dual temperature pumps and central air handling units of these buildings were cycled based on reduced space temperature setpoints during unoccupied hours. Spaces

with individual fan-coil units were not considered for hookup to the new UMCS installation, as the energy use per control point is very low.

By installing a local panel with an average of twenty inputs and outputs in each building, each building's DT pump or air-handling units are cycled on and off during unoccupied hours. The units cycle based on the space temperature. Refer to *Figure 3.1.7.1* for a typical miscellaneous-group building system configuration. *Table 3.1.7.1* lists the buildings considered for this ECO, the number of control points required per building, costs and savings used in the analysis. Calculations, cost estimates and life-cycle cost analyses for this ECO are found in *Appendix C*. See *Table 3.1.7.2* for savings/costs of ECO 1G.

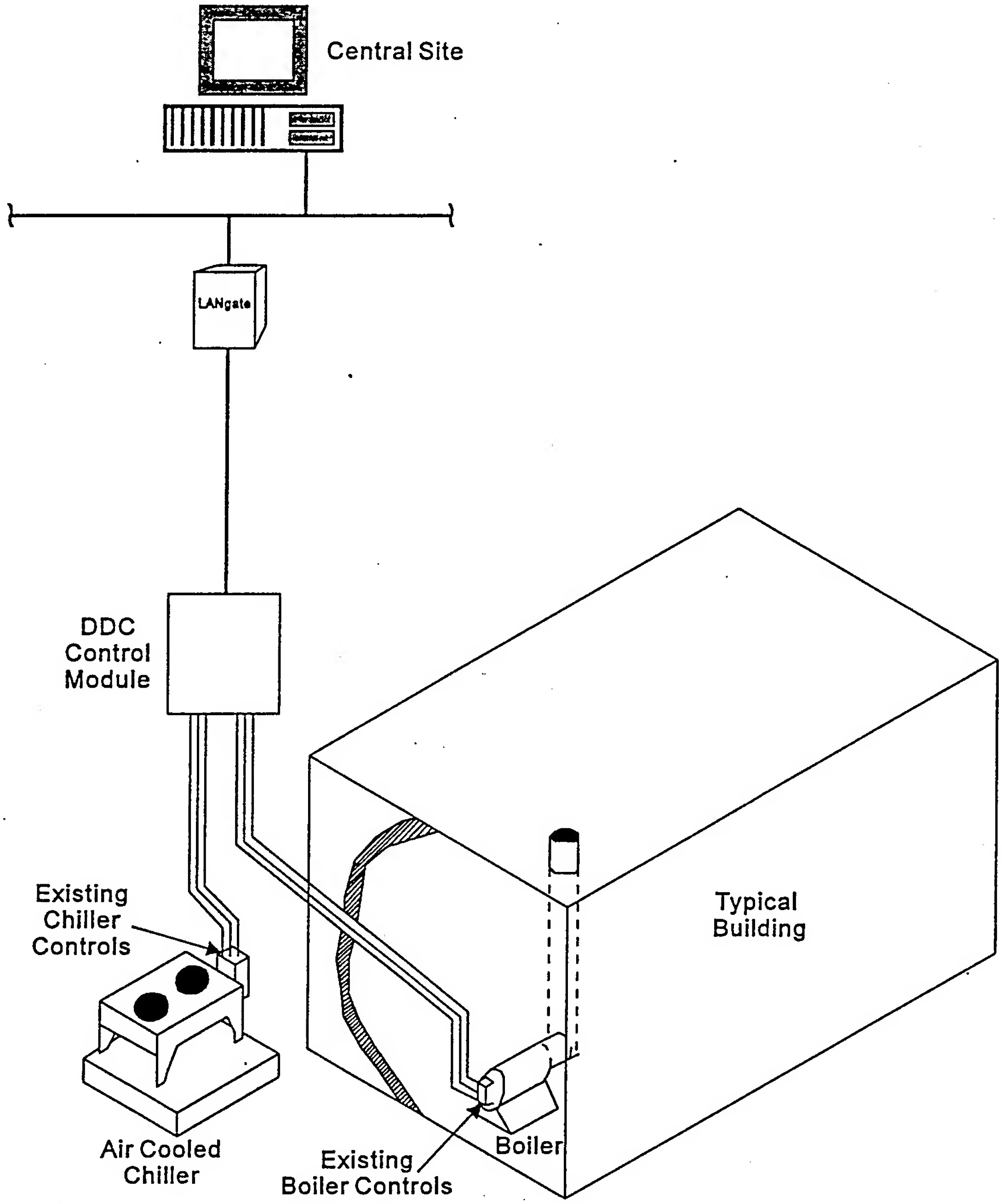


Figure 3.1.7.1

TYPICAL MISCELLANEOUS - GROUP BUILDING SYSTEM CONFIGURATION

TABLE 3.1.7.1

ECO 1G - HVAC - MISCELLANEOUS BUILDINGS: COSTS/SAVINGS

Bldg	Points*	Instal. Cost/Point	Total Cost	Maint Savings	Energy Savings		Demand Savings
					Nat Gas	Electric	
38	24	491	$14,044	$320	$1,372	$53	$0
89	20	491	$12,080	$320	$1,007	$39	$0
91	20	491	$12,080	$320	$1,116	$50	$0
93	20	491	$12,080	$320	$1,647	$140	$0
96	5	885	$6,685	$0	$554	$18	$0
98	80	378	$32,500	$1,280	$8,204	$263	$0
2702	80	378	$32,500	$1,280	$8,386	$269	$0
3202	20	491	$12,080	$320	$1,157	$52	$0
3603	20	491	$12,080	$320	$1,256	$57	$0
3958	5	885	$6,685	$0	$531	$17	$0
5207	20	491	$12,080	$320	$13,399	$573	$0
5580	20	491	$12,080	$320	$1,256	$57	$0
5663	20	491	$12,080	$320	$1,060	$74	$0
5702	20	491	$12,080	$320	$1,157	$52	$0
5875	20	491	$12,080	$320	$884	$34	$0
5980	20	491	$12,080	$320	$1,055	$48	$0
6551	87	378	$32,890	$320	$0	$1,040	$0
6555	87	378	$32,890	$320	$0	$1,040	$0
6559	87	378	$32,890	$320	$0	$1,040	$0
6564	87	378	$32,890	$320	$0	$1,040	$0
6721	20	491	$12,080	$320	$692	$27	$0

*For a description of control points, see Appendix C.

Table 3.1.7.2 ECO 1G - HVAC - MISCELLANEOUS BUILDINGSS: COSTS/SAVINGS SUMAMRY	
Construction Cost (see cost estimate in Appendix C)	$368,934
Annual Energy /Savings / Costs	
Electrical Energy (MBtu/Yr)	967
Electrical Demand ($/Yr)	
Thermal Energy (MBtu/Yr)	
Natural Gas (Mbtu/Yr)	7,088
Fuel Oil	
Non-Energy Savings / Costs Operation / Maintenance ($/Yr)	$8,000
Non-Recurring Savings / Costs	$425,627

3.2 ECONOMIC ANALYSIS

3.2.1 Investment Costs

For investment cost estimating, pricing was performed at the building level for the components particular to each building such as control modules, sensors, actuators and wiring. Common components such as the head-end computer network, post-wide fiber optic cabling, software and programming were priced separately. The total cost of the common components was then divided among the buildings based on the number of points per building, and this shared cost was added to each individual building's cost estimate. Therefore each individual building estimate shares the actual cost of the equipment which is necessary to the functioning of the whole UMCS but is not directly associated with the individual building cost.

3.2.2 Energy Costs/Savings

The bin method, as described in the *ASHRAE 1993 Fundamentals Hand Book*, is used to calculate

energy savings associated with temperature set-backs and step-ups and with reduced outside air achieved by controlling exhaust fans. Assumptions used in the calculations are made conservatively to insure that energy savings are not overestimated.

Energy savings calculations for 150 buildings were used to determine potential savings associated with connecting the building's heating ventilation and air conditioning systems to the proposed SCADA system. Energy savings are based on temperature set back during unoccupied hours, outside air reduction during unoccupied hours, cycling of secondary loop pumps, chilled water reset, and maintaining higher boiler efficiency. Weather bin data taken from TM 5-785 was used to determine the savings during unoccupied periods. Savings associated with heating is calculated only for the winter months (October - March) and savings associated with cooling is only calculated only for the summer (April - September). The actual hours that the savings occur may vary. This is particularly true of barracks that may be occupied during the day on occasion, but may also be unoccupied for extended periods due to troop rotation or field exercises. For this reason, unoccupied hours for the barracks occur from 8 a.m. to 4 p.m. The EMCS operator has the ability to control occupancy schedules to ensure maximum energy savings during unoccupied periods.

3.2.2.1 Outside Air Reduction

The calculation of annual energy savings associated with reducing the outside air during unoccupied times is show in *Appendix C*. Where as-built information was unavailable, the outside air is assumed to be 20 percent of the supply air except in the dining facilities and clubs, where it is 50 percent. The designed supply air is one cubic foot per minute (CFM) per square foot. These assumptions are based on "check figures" from the ASHRAE pocket guide for HVAC designers for these types of facilities.

Following is a sample calculation for outside air reduction energy savings:

Sample Calculation
Building 3672 (Administrative Type) - Outside Air Reduction

The savings resulting from reducing outside air during unoccupied times during the summer months is calculated by the equation:

Equation 1

$$Q_s = \Sigma(\Delta\ CFM)\ (\Delta\ h)\ (4.45)\ (t)\ ;\ where$$

Q_s = summer energy savings (Btu/hr)
Δ CFM = reduced outside air quantity (CFM)
Δ h = enthalpy difference between outside air and indoor air (Btu/lbm)
t = number of hours per year that the space is unoccupied during the summer months (hrs/yr)

The unoccupied period for office buildings is during the night and on weekends. The enthalpy difference is determined by subtracting the outside air enthalpy from the indoor air enthalpy. The enthalpy of the indoor air is based on 82 degrees Fahrenheit (the unoccupied setup point) and 50 percent relative humidity. From the Psychrometric Chart (*Figure 3.2.2.1*), the indoor air enthalpy is 32.7 Btu/lb. The enthalpy of the outside air is found for each bin, using the average dry bulb temperature for each bin and mean coincident wet bulb temperature. The enthalpy difference for each bin is shown in *Table 3.2.2.1,* along with the number of hours of occurrence per year during nighttime and daytime hours.

Daytime savings occur only on weekends when the space is unoccupied. Therefore, the daytime hours must be multiplied by 2/7 (0.2857) when applying *Equation 1*.

PSYCHOMETRIC CHART

Figure 3.2.2.1

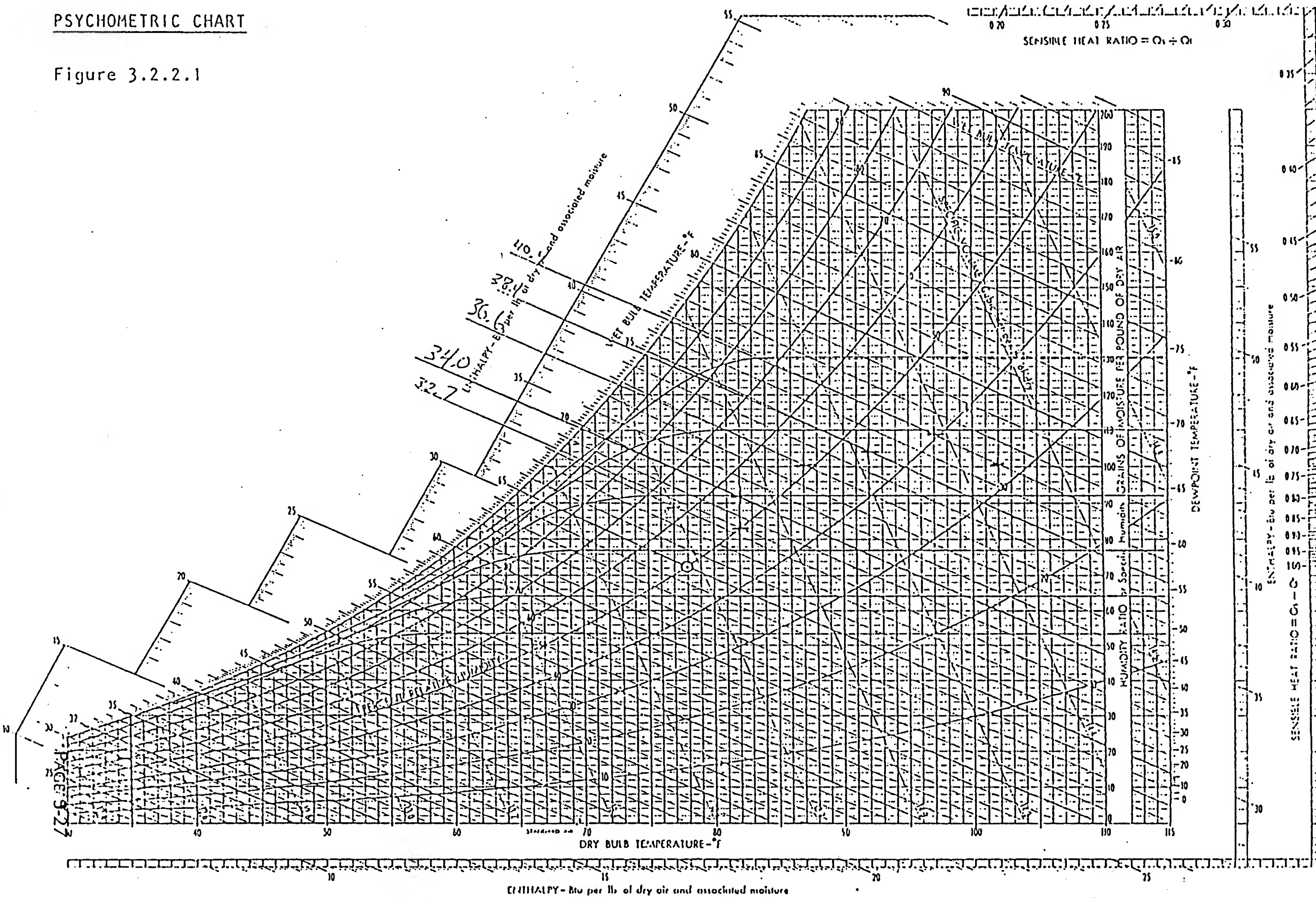


Table 3.2.2.1
ENTHALPY DIFFERENCE AT VARIOUS TEMPERATURE BINS
(ADMINISTRATION BUILDINGS)

Average Dry Bulb Temperature (°F)	Mean Coincident Wet Bulb Temperature (°F)	Enthalpy, h [Btu/lb]	Enthalpy Difference, Δh [h-32.7]	Night t [hr/yr]	Day t [hr/yr]
102/97	77	40.4	7.7	3	24
92	75	38.4	5.7	17	94
87	73	36.6	3.9	75	277
82	70	34.0	1.3	185	355

Equation 1 can be simplified by substituting Δh and t from *Table 3.2.2.1.*

$$Q_s = \Delta CFM \ \left((7.7)(4.45)(3) + (5.7)(4.45)(17) + (3.9)(4.45)(75) + (1.3)(4.45)(185)\right) + 0.2857\,[(7.7)(4.45)(24) + (5.7)(4.45)(94) + (3.9)(4.45)(277) + (1.3)(4.45)(355)]$$

Equation 2

$$Q_s = 5800 \bullet \Delta CFM$$

The reduced outside air for each building is given on pages C-70 - C-74. The reduced CFM for building 3672 is 5048 CFM; therefore, the reduced cooling load is:

$$Q_s = 5800\ (5048)$$

$$Q_s = 29{,}278{,}400$$

Or, $Q_s = 29.3$ MBtu/yr

This number is shown in the tables in *Appendix C* under the heading "Savings - Summer." The equation differs for barracks calculations where CFM reduction occurs during daytime hours. The equation for daytime infiltration reduction is derived in a similar manner to *Equation 2,* using the values in *Table 3.2.2.2.*

Table 3.2.2.2
ENTHALPY DIFFERENCE AT VARIOUS TEMPERATURE BINS (BARRACKS)

Average Dry Bulb Temperature (°F)	Mean Coincident Wet Bulb Temperature (°F)	Enthalpy, h [Btu/lb]	Enthalpy Difference, Δh [h-32.7]	Day t [hr/yr]
102/97	77	40.4	7.7	24
92	75	38.4	5.7	94
87	73	36.6	3.9	277
82	70	34.0	1.3	355

Equation 1 can be simplified by substituting Δh and t from *Table 3.2.2.2.*

$$Q_s = \Delta CFM \;\; 5/7$$
$$\big((7.7)(4.45)(24) + (5.7)(4.45)(94) + (3.9)(4.45)(277) + (1.3)(4.45)(355)\big)$$

Equation 3

$$Q_s = 7{,}100 \bullet \Delta CFM$$

Similarly, the savings resulting from reducing outside air during unoccupied times during the winter months is calculated with the equation:

Equation 4

$$Q_w = \sum (\Delta\, CFM)\,(1.085)\,(\Delta T)\,(t)\,; \quad where,$$

Q_W	=	winter energy savings (Btu/hr)
ΔCFM	=	reduced outside air quantity (CFM)
Δ T	=	temperature difference between outside air and indoor air (°F)
t	=	number of hours per year that the space is unoccupied during the winter months (hrs/yr)

The temperature difference is determined by subtracting the average outside air temperature for each bin from 57 degrees Fahrenheit (the winter unoccupied set point). Equation 4 can be simplified by substituting the temperature differences and hours for each bin and factoring out 1.085 (Δ CFM)

Q_w = (1.085) (Δ CFM) {[65(1) + 60(8) + 55(10) + 50(24) + 45 (40) + 40(92) + 35(174) + 30(286) + 25(406) + 20(404) + 15(427) + 10(409) + 5(441)] + 0.2857 [55(2) + 50(5) + 45(10) +40(17) + 35(38) + 30(72) + 25 (132) + 20 (160) + 15(181) + 10(174) + 5(191)]}

Equation 5

$$Q_w = 63{,}200 \bullet \Delta CFM$$

Equation 5 is based on a building that is unoccupied during the night and on weekends. The hours for each bin varies during the day and so the equation for winter savings for barracks is given by:

Q_w = 5/7 (1.085) (Δ CFM) {[55(2) + 50(5) + 45(10) + 40(17) + 35 (38) + 30(72) + 25(132) + 20(160) + 15(181) +10(174) + 5(191)]

Equation 6

$$Q_w = 13{,}100 \bullet \Delta CFM$$

Equation 5 can be solved for Building 3672 which has an outside air flow of 5,048 CFM.

Q_w = (63,200) (5048)

Q_w = 319,033,600 Btu/yr

Or,

Q_w = 319 MBtu/yr

The winter savings for outside air reduction is shown for all buildings in the tables in *Appendix C.*

3.2.2.2 Temperature Set Back

Appendix C contains the tables which show the annual energy savings associated with the set back of temperature during unoccupied times. The summer setpoint is 82 degrees Fahrenheit during the unoccupied times and the winter setpoint is 57 degrees Fahrenheit during unoccupied times.

The following is a sample calculation of energy savings from temperature setback/setup:

Sample Calculation
Building 3672 (Administrative Type) - Temperature Setback

The savings resulting from winter setback and summer setup is based on the transmission losses through the building structure. The basic equation for transmission losses is:

Equation 7

$$Q = U_w A_w \Delta T + U_R A_R \Delta T, \qquad where,$$

Q	=	heat transferred [Btu/hr]
U_w	=	wall heat transfer coefficient [Btu/hr • Ft^2 • °F]
ΔT	=	temperature difference [°F]
A_W	=	total wall area [Ft^2]
U_R	=	roof heat transfer coefficient [Btu/hr • Ft^2 • °F]
A_R	=	roof area [Ft^2]

The overall heat transfer coefficient can be calculated for a given construction type with the equation:

$$U = \frac{1}{\Sigma R} : \quad where\ R = Thermal\ Resistance$$

For Building 3672, the heat transfer coefficients are calculated as follows, based on R-values for building components as given in the *ASHRAE Fundamentals Handbook*:

1)	outside air film,	R = 0.17
2)	8" perlite filled concrete block,	R = 2.1

3) Non-Reflective air space, R =1.01

4) ½" Gypsum board, R = 0.45

5) Inside air film, R = 0.70

Total R-value = 4.43

$$\therefore \; U_W = \frac{1}{4.43} = 0.226 \text{ Btu/hr} \cdot \text{Ft}^2 \cdot {}^\circ\text{F}$$

In a similar manner, the heat transfer coefficient for a built-up roof is found to be :

Outside air film	R	= 0.17
Built-up roof	R	= 0.33
Rigid deck insulation	R	= 1.39
Plydeck deck, 0.635 in.	R	= 0.78
Nonreflective air space	R	= 0.93
Gypsum wallboard, 0.5 in.	R	= 0.45
Acoustical tile, 0.5 in.	R	= 1.42
Inside air film	R	= 0.70
Total R-Value		**= 6.17**

$$\therefore \; U_R = \frac{1}{6.17} = 0.162 \text{ Btu/hr} \cdot \text{Ft}^2 \cdot {}^\circ\text{F}$$

The energy savings from reduced heat transfer through the walls due to a 10°F temperature setup during unoccupied hours in the summer is given by:

Equation 8

$$\Delta Q_{SW} = U_{W_1} A_{W_1} \Delta T_1 - U_{W_2} A_{W_2} \Delta T_2 ; \quad where,$$

ΔQ_{SW} = reduced heat transfer through walls during unoccupied times in the summer

$$U_{W_1} = U_{W_2} = U_W = 0.226\ Btu/hr \bullet Ft^2 \bullet {}^\circ F$$

$$A_{W_1} = A_{W_2} = A_W$$

$$\Delta T_1 = T_B - T_{I_1}$$

$$\Delta T_2 = T_B - T_{I_2}$$

Where:

T_B = average bin temperature

T_{I_1} = inside temperature before setup

T_{I_2} = inside temperature after setup

$$T_{I_2} = T_{I_1} + 10,\ for\ 10^\circ F\ setup\ when\ T_B \geq T_{I_1} + 10$$

$$T_{I_2} = T_{I_1} + 5,\ when\ T_B = T_{I_1} + 5$$

T_{I_1}, T_{I_2} and T_B can be substituted into *Equation 8* and simplified to get the following:

$$\Delta Q_{S_W} = U_W A_W \, [(T_B - T_{I_1}) - (T_B - T_{I_2})]$$

When the bin temperature is 5°F greater than the initial inside air temperature, the reduction in heat transfer is:

Equation 9

$$\Delta Q_{SW} = U_W A_W \, [(T_B - T_{I_1}) - (T_B - (T_{I_1} + 5)]$$
$$\Delta Q_{SW} = U_W A_W \bullet 5$$

And when the bin temperature is at least 10°F greater than the initial inside temperature, the reduction in heat transfer is:

Equation 10

$$\Delta Q_{SW} = U_W A_W \, [(T_B - T_{I_1}) - (T_B - (T_{I_1} + 10)]$$
$$\Delta Q_{SW} = U_W A_W \bullet 10$$

Equations 9 and 10 can be used to determine the reduction of heat transfer through the roof by substituting U_R and A_R for U_W and A_W, respectively. The energy loss is determined by multiplying *Equation 9* by the unoccupied hours per year during the summer that the bin temperature is 5°F above the initial building set point and multiplying *Equation 10* by the number of unoccupied hours per year during the summer that the bin temperature is at least 10°F above the building set point. The total summer energy savings from temperature setup is given by the equation:

Equation 11

$$ES_S = 5 \bullet t_1 \, (U_W A_W + U_R A_R) + 10 \bullet t_2 \, (U_W A_W + U_R A_R)$$
$$t_1 = Hours/Year \text{ that } T_B = T_{I_1} + 5°F$$
$$t_2 = Hours/Year \text{ that } T_B \geq T_{I_1} + 10°F$$

For Building 3672:

U_W = 0.226 Btu/hr • Ft_2 • °F

U_R = 0.162 Btu/hr • Ft_2 • °F

A_W = 6,355 Ft_2 (from real property records)

A_R = 25,241 Ft_2 (from real property records)

t_1 = 395 + 0.2857 (269) = 472 hr/yr

t_2 = 279 + 0.2857 (717) = 484 hr/yr

ES_s = [5(472) + 10 (484)] [(0.226) (6,355) + (0.162) (25,241)]

ES_s = (7,200) (5,525)

ES_s = 39,780,000 Btu/Yr

Or,

ES_s = 39.8 MBtu/Yr

Equation 11 can be used for winter calculation setback savings, except that:

t_1 = Hours/Year that $T_B = T_{I_1} - 5°F$

t_2 = Hours/Year that $T_B \leq T_{I_1} - 10°F$

For Building 3672 winter savings:

T_1 = 167 Hr/Yr + 0.2857 (132 hr/yr) = 205 hr/yr

T_2 = 2,599 Hr/Yr + 0.2857 (1064 hr/yr) = 2,903 hr/yr

ES_W = [5(205) + 10 (2,903)] (5,525)

ES_W = 166,053,875 Btu/Hr

Or,

$ES_W = 166.1$ MBtu/Yr

Equation 11 can be used to calculate the energy savings resulting from winter setback and summer setup in the barracks also. The barracks are unoccupied Monday through Friday during the day, and so in the summer, t_1 and t_2 are:

$t_1 = 5/7\ (269) = 192$ hr/yr
$t_2 = 5/7\ (717) = 512$ hr/yr

And *Equation 11* simplifies to:

$$ES_S = [5(192) + 10(512)]\ [(0.226)\ (A_W) + (0.162)\ (A_R)]$$

$$ES_S = 6{,}080\ (0.226\ A_W + 0.162\ A_R)$$

During the winter, the times are:

$t_1 = 5/7\ (132) = 94$ hr/yr

$t_2 = 5/7\ (1{,}064) = 760$ hr/yr

And *Equation 11* simplified to:

$$ES_W = [5(94) + 10(760)]\ [(0.226)\ (A_W) + (0.162)\ A_R]$$

$$ES_W = 8{,}070\ (0.226\ A_w + 0.162\ A_R)$$

The equations developed in this section are built into the spreadsheets included in *Appendix C* for the calculation of energy savings resulting from temperature set point adjustments and outside air reduction during unoccupied periods.

3.2.2.3 Demand Savings

Demand savings can be achieved in the barracks and administrative buildings by cycling the dual temperature pumps, assuming the buildings are divided into three blocks and that two of the three blocks require pumping at all times. The equation of demand savings is given as,

$$DS = (0.3)(P)(DC)(N), \text{ where;}$$

DS = demand savings [$/yr]
P = pump power [kW]
DC = demand charge [$/kW · mo]
N = number of months per year [mo/yr]

The pumping power is to be 80 percent of the name plate power.

3.2.2.4 Chilled Water Temperature Reset

Chilled water temperature reset savings are based on energy savings resulting from raising the chilled water temperature when the load on the loop can be met with higher temperature chilled water. Ten percent of the energy required to cool a building can be saved by resetting the chiller water temperature. These savings result from reducing temperature lift, which is the chief factor in determining compression work input per unit of flow. The equation for temperature lift is given as:

$$T.L. = (LCWT - LEWT) + (LEWT - ET_p) + (CT_p - LCWT)$$

TL = temperature lift
LCWT = leaving condenser water temperature
LEWT = leaving evaporator water temperature
ET_p = refrigerant evaporator temperature
CT_p = refrigerant condenser temperature

The energy consumption is given by the equation:

$$kW/ton \propto \frac{(lbm/min/ton)\ (T.L.)}{\eta_c\ \eta_m\ \eta_e}$$

lbm/min/ton refers to the refrigerant mass flow rate.

T.L. = temperature lift

η_c = compression efficiency

η_m = mechanical efficiency

η_e = electrical efficiency

Raising the chilled water set point lowers the temperature lift and increases the compression efficiency. This will decrease the average energy use from approximately 1.21 kilowatts per ton of space cooling to approximately 1.1 kilowatts per ton of space cooling. This is energy savings of approximately 10 percent. The baseline cooling energy is based on 1,400 full-load cooling hours at chiller design capacity.

3.2.2.5 Boiler Efficiency Monitoring

The proposed SCADA system will allow close monitoring of boiler efficiency. The ease of monitoring boiler efficiency will allow boiler operators to make adjustments and maintain optimum boiler operating efficiency. It is estimated that an average of three percent increase in efficiency can be achieved by more closely monitoring boiler operation. The energy savings is determined by multiplying the annual boiler output by the three percent increase in efficiency.

3.2.3 Maintenance Costs/Savings

Maintenance savings were estimated based on an average savings of eight man-hours per year for each air handler. These savings are conservative since they consider only the savings associated with actual maintenance and troubleshooting time, not savings associated with lost occupant productivity.

3.2.4 Non-Recurring Costs/Savings

Because life-cycle costing guidelines require using a ten-year life for HVAC controls, a one-time cost of replacing existing HVAC local controls was placed in year five of each life-cycle cost analysis. Most, if not all, the existing control systems surveyed were approaching 20 years old. The avoided cost was assumed to be half of the estimated cost of the local control modules proposed in this study.

4.0 ECO 2: ELECTRICAL SUBSTATIONS

4.1 SYSTEM DESCRIPTION

Power for Fort Campbell is supplied by TVA through the Edgoten 161:69 kilovolt substation. The power is provided to the installation through the 69 kilovolt switching station which provides power to eight 67:12.47/7.2 kilovolt substations. Each substation typically will have a 69 kilovolt distribution fuse cut-out or a 69 kilovolt main circuit breaker, 67:12.47/7.2 kilovolt transformers, voltage regulators, and a specific number of 12.5 kilovolt oil circuit breakers for distribution feeder circuits. Currently Fort Campbell receives electrical energy and demand data from TVA billings. There is no monitoring or metering capability available at the installation at the substation level. Therefore, no information is available on each of the substation's electrical load and each of the individual feeder's electrical load. The information is necessary for proper electrical utility utilization and management.

4.2 METHOD OF APPLICATION

The UMCS/SCADA system will incorporate circuit monitoring devices such as Square D-POWERLOGIC Series or equivalent system, into the network. The circuit monitor will provide the UMCS/SCADA system the capability to monitor, control, and manage electrical loads effectively and efficiently.

4.2.1 Circuit Monitor Functions

The circuit monitor has three major functions: metering, data communication, information processing and display. The system is only as good as its weakest link; all three functions must be performed well if the system manager or operator is to have clear and easily accessible information. The information is then used to help manage the total electrical utility system investment: energy costs, the costs of operation and maintenance, and the cost of power equipment itself.

4.2.2 Application Benefits

The circuit monitoring system gives engineers and managers accurate and meaningful information about circuit loading, energy usage patterns, kilowatt demand levels, power factor trends, and equipment status. This will be very helpful to Fort Campbell since no monitoring capability exists for most of the installation's electrical systems, not even at the local level. Some of the benefits received from the circuit monitoring function of the SCADA system include:

- ⇨ Lower power bills as the information shows ways to cut demand and power factor penalties and reduce energy waste.
- ⇨ Savings in man-hours related to data collection for circuit loading, energy consumption, and equipment status.
- ⇨ Reduced downtime and maintenance costs as information warnings of impending failures allow problems to be fixed before the money is lost.
- ⇨ Delayed capital costs as historical loading information permits existing electrical equipment to be confidently operated closer to its design limits.
- ⇨ Accurate information concerning existing electrical system capacity and circuit loading necessary for proper planning of future facility renovation and expansion projects.
- ⇨ Tools for power quality problem detection.
- ⇨ Tools for power distribution protective functions and management of power outages.

4.2.3 Points of Application

The POWERLOGIC Circuit Monitor is used to perform the following functions at each of the substations. Refer to *Figure 4.2.3.1 - Figure 4.2.3.8* for the illustrations of the application.

1) A circuit monitor will be used to monitor the electrical load of the substations. A circuit monitor will be installed on the substation main feeder/breaker to monitor the electrical load conditions and load characteristics as outlined on the circuit monitor schedule. PT's and CT's

Fort Campbell 69KV System

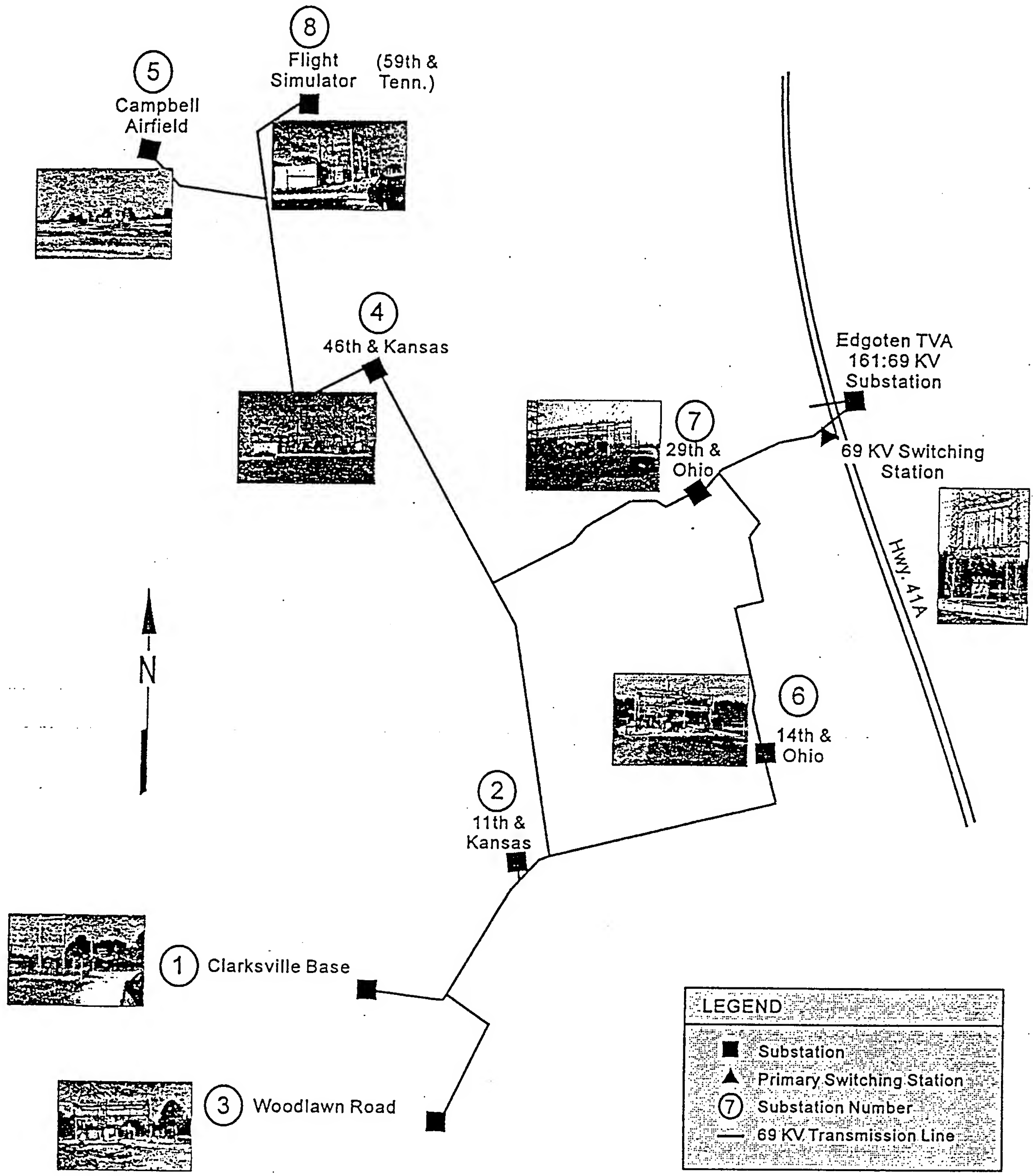


Figure 4.2.3.1

Substation Switching Arrangement
Fort Campbell, Kentucky

Clarksville Substation I

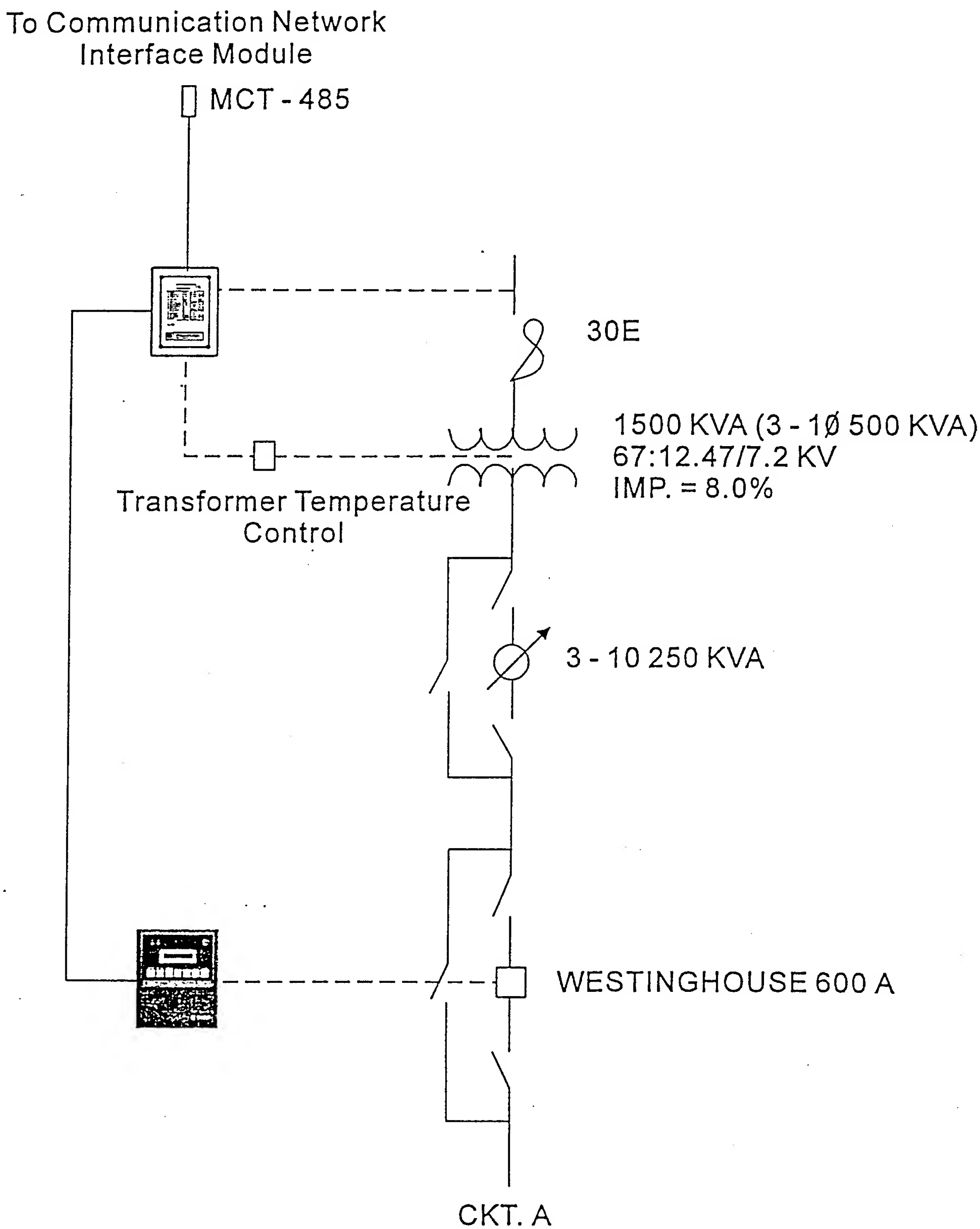


Figure 4.2.3.2

Substation Switching Arrangement
Fort Campbell, Kentucky

11th & Kansas Substation 2

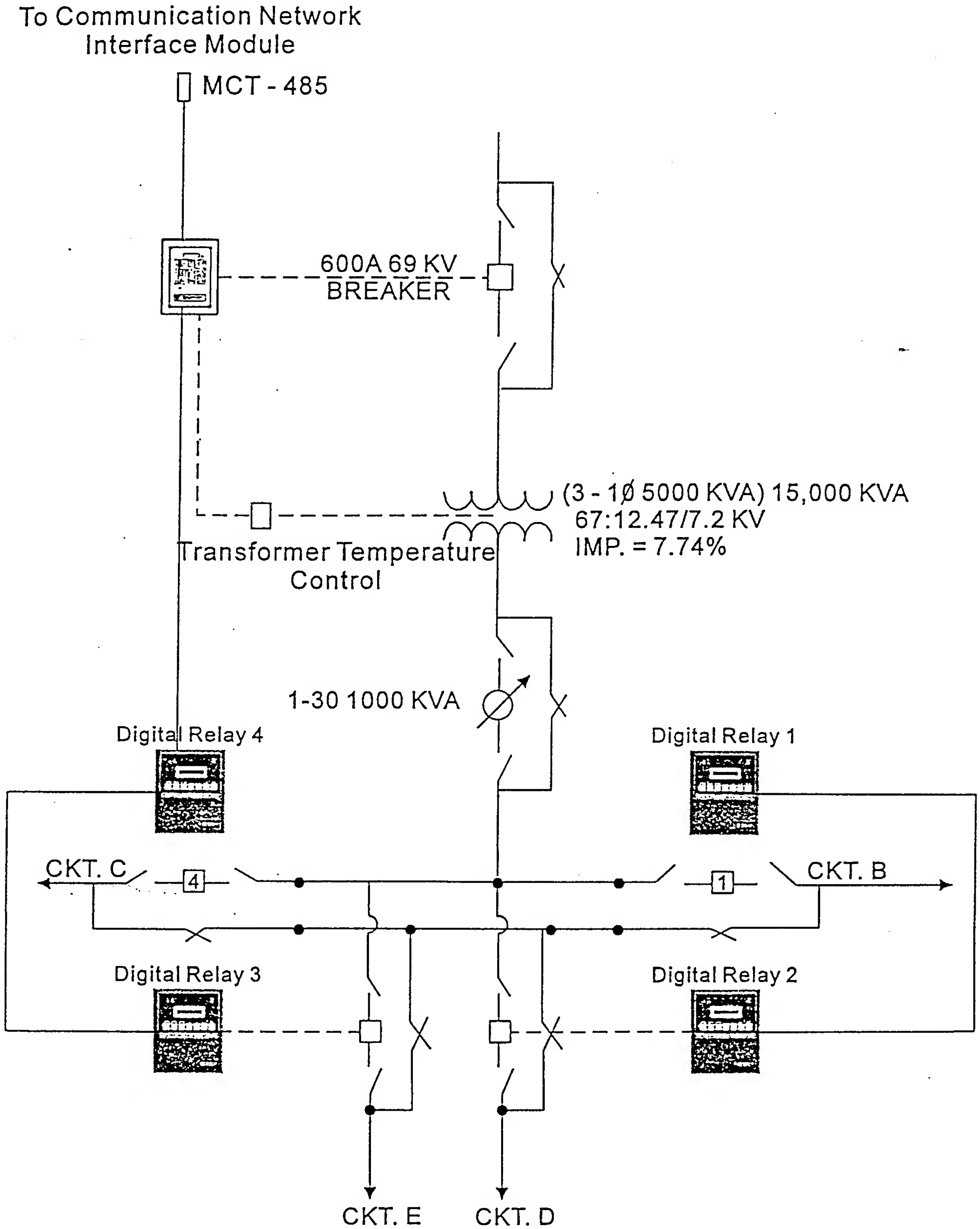


Figure 4.2.3.3

Substation Switching Arrangement
Fort Campbell, Kentucky

Woodlawn Road Substation 3

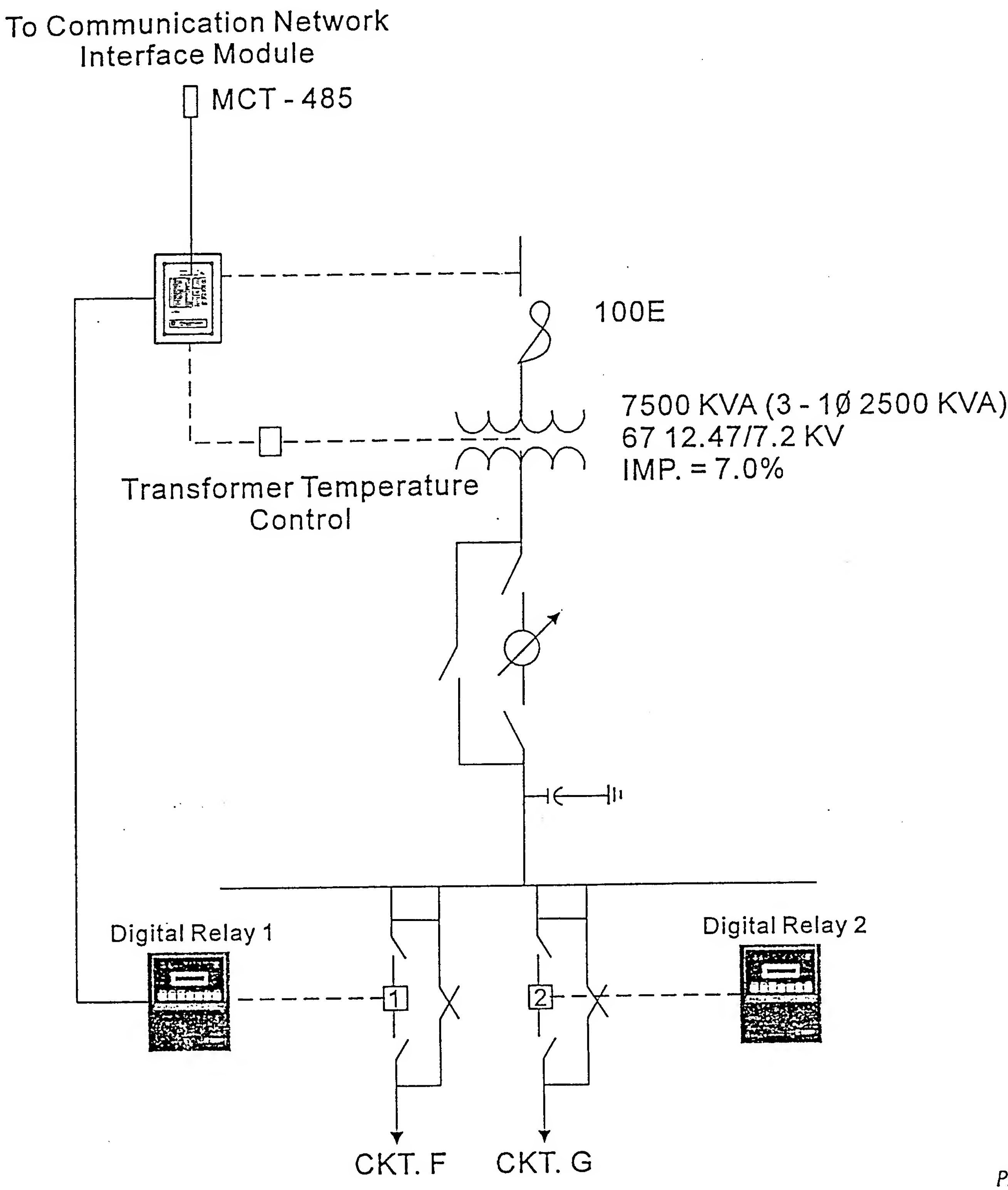


Figure 4.2.3.4

Substation Switching Arrangement
Fort Campbell, Kentucky

47th & Kansas Substation 4

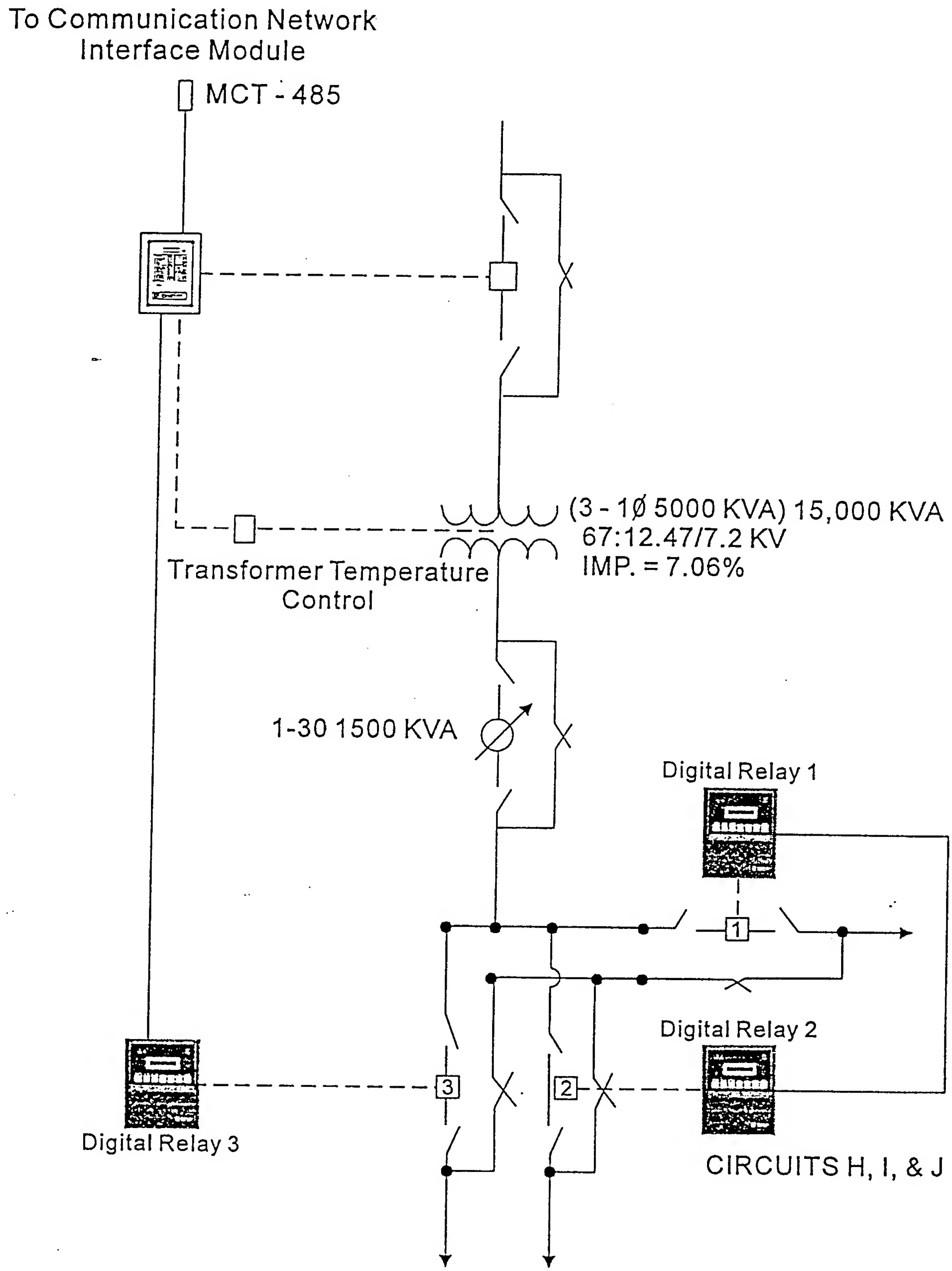


Figure 4.2.3.5

Substation Switching Arrangement
Fort Campbell, Kentucky

Campbell Army Airfield Substation 5

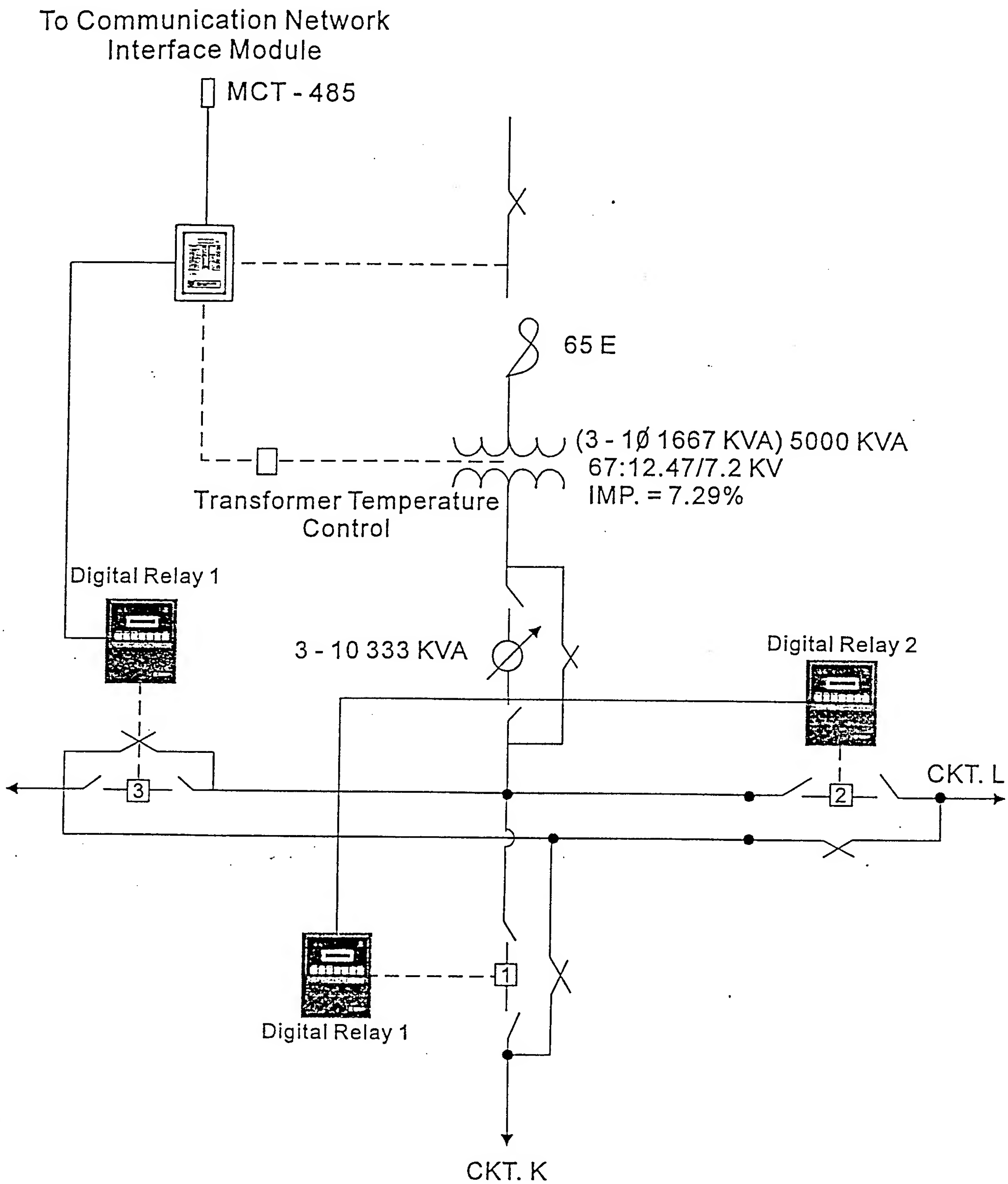


Figure 4.2.3.6

Substation Switching Arrangement
Fort Campbell, Kentucky

14th & Ohio Substation 6

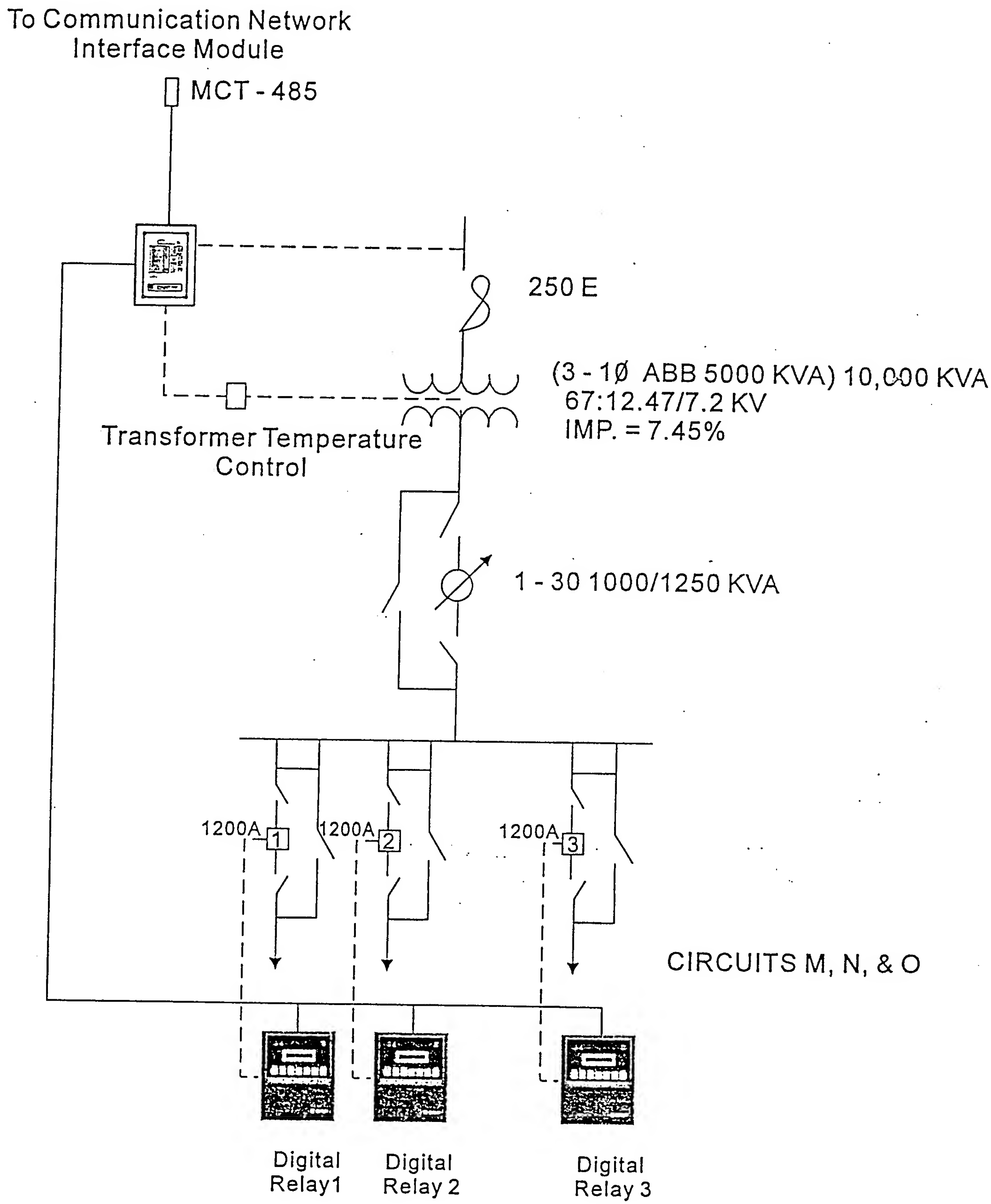
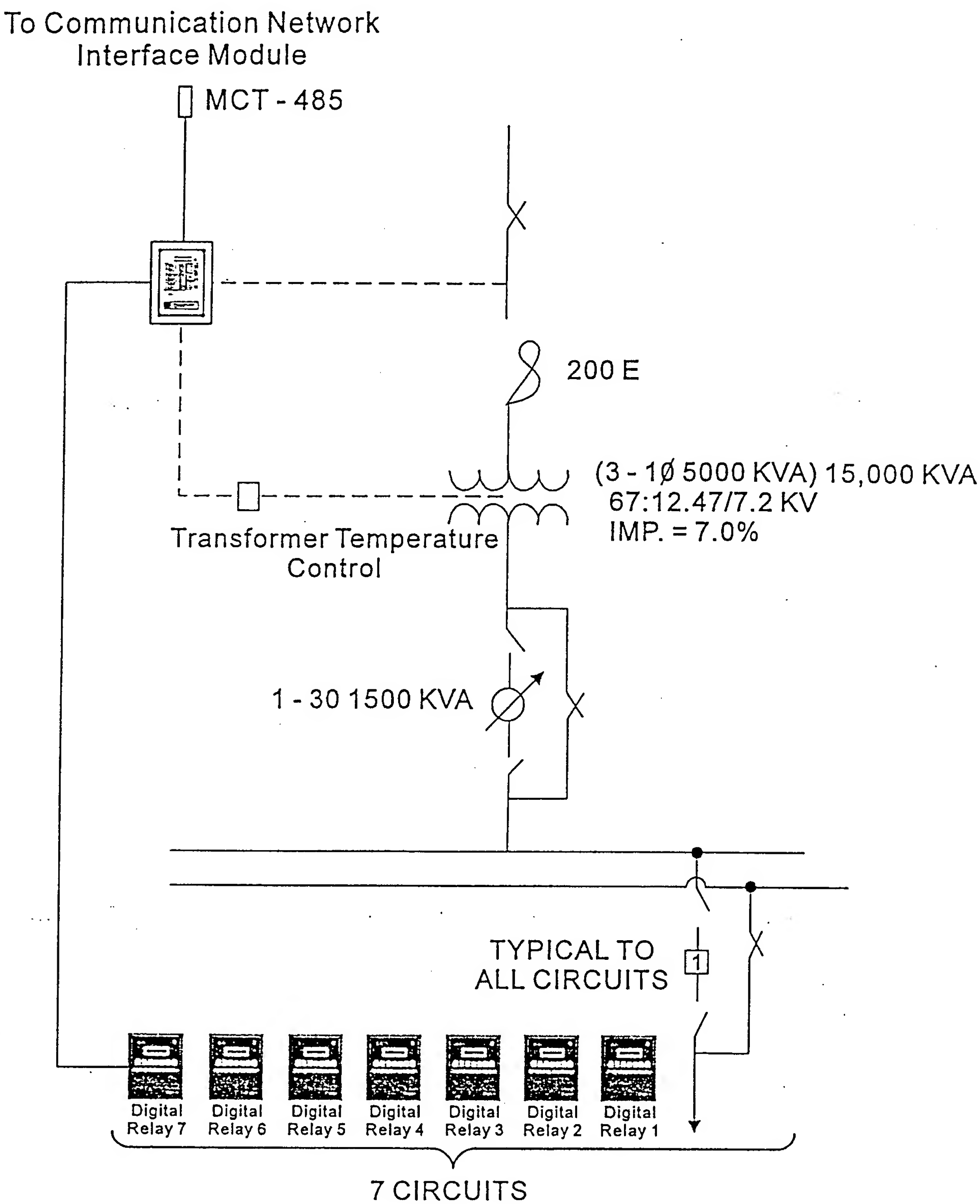


Figure 4.2.3.7

Substation Switching Arrangement
Fort Campbell, Kentucky

29th & Ohio Substation 7



CIRCUITS P, Q, S, T, U, & V

Figure 4.2.3.8

will need to be installed on the substation main feeder circuit. See *Table 4.2.3.1, Substation Metering and Monitoring Function Schedule.*

2) A digital relay circuit monitor will be use to monitor the electrical load of individual distribution feeder circuits and to monitor and control oil circuit breaker positions. A digital relay package along with a circuit interface module will be installed on each of the distribution feeder circuit breakers to remotely monitor RMS currents, demand currents, breaker status, and trip causes (type, fault magnitude). The digital relay combines three-phase overcurrent protection (ANSI 50/51) and ground overcurrent protection (50/51N) into a single, compact package. The relay accepts current inputs from standard 5-ampere current transformers. Time-current characteristics are independently adjustable for phase and ground from a variety of curve shapes (inverse, very inverse, extremely inverse, etc.) Closer tolerances on relay pickup settings and flexible time delay adjustments permit better coordination with upstream and downstream devices. PT's and CT's will need to be installed on each of the distribution feeder circuits.

3) A transformer temperature control module will be used to monitor transformer temperature. A transformer temperature control module along with a circuit monitor interface device will be installed on each of the distribution transformers to monitor overload or other abnormal conditions which cause the transformer to operate outside its operating temperature parameters.

4) Once the power and load characteristics become available, the information can be used for power factor correction application to make maximum use of feeder capacity and to reduce line loss. Power factor switching control can be added after the electrical load characteristic has been determine and analyzed for proper application of power factor correction capacitor. The switch control can then be tied into the circuit monitor to optimize power usage.

5) The electrical loading information will also be used to coordinate and manage load shedding schemes.

Table 4.2.3.1

SUBSTATION METERING AND MONITORING FUNCTION SCHEDULE

CM-A

CIRCUIT MONITOR FOR MONITORING OF 15 KV MAIN CIRCUIT BREAKERS CONSISTS OF POWERLOGIC CIRCUIT MONITOR CAT NO. 3020 CM2050 AND IOM18 8-POINT MODULE WITH MAIN BREAKER AUXILIARY CONTACT AND 125 VDC BATTERY UNDERVOLTAGE ALARM CONTACT WIRED TO INPUT TERMINALS FOR INDICATION AND ALARMING AT THE POWER MONITORING COMPUTER STATION.

CM-B

CIRCUIT MONITOR FOR MONITORING OF NETWORK PROTECTORS CONSISTS OF POWERLOGIC CIRCUIT MONITOR CAT NO. 3020 CM2050 AND IOM18 8-POINT MODULE WITH NETWORK PROTECTOR AUXILIARY CONTACT AND TRANSFORMER HI-TEMPERATURE ALARM CONTACT WIRED TO INPUT TERMINALS FOR INDICATION AND ALARMING AT THE POWER MONITORING COMPUTER STATION.

DR

DIGITAL RELAY (50/51) FOR MONITORING OF 15KV FEEDER BREAKERS CONSISTS OF DIGITAL RELAY WITH COMMUNICATIONS CAPABILITY TO POWERLOGIC AND BREAKER CLOSE/OPEN STATUS INDICATION.

SUBSTATION CIRCUIT MONITOR: CM-A, B

METERED/MONITORED VALUE	DISPLAYED AT EQUIPMENT	DISPLAYED AT COMPUTER
RMS PHASE CURRENT	X	X
PHASE TO PHASE VOLTS	X	X
PHASE TO NEUTRAL VOLTS	X	X
REAL POWER (KW)	X	X
REACTIVE POWER (KVAR)	X	X
APPARENT POWER (KVA)	X	X
POWER FACTOR (PF)	X	X
ENERGY (KWH)	X	X
FREQUENCY	X	X
PEAK DEMAND (KW)	X	X
DEVICE POSITION (OPEN/CLOSED)		X

SUBSTATION DIGITAL RELAY (50/51)

METERED/MONITORED VALUE	DISPLAYED AT EQUIPMENT	DISPLAYED AT COMPUTER
RMS PHASE CURRENT	X	X
EVENT LOG		X
INDICATE TRIP TYPE (OVERLOAD OR GF)	X	X
DEVICE POSITION (OPEN/CLOSED)		X

4.3 ECONOMIC ANALYSIS

4.3.1 Investment Costs

Investment cost estimating was performed for the monitoring of all substations including all of the distribution feeder circuits, the substation feeder circuits, and the substation transformers. The common components of the communications network including head-end computer equipment, post-wide fiber optic cabling, wireless modems, software and programming were priced separately. The total cost of the common components was then divided among the systems on the network based on the number of communication nodes. See Cost Estimate in *Appendix C*.

4.3.2 Energy Costs/Savings

There is no direct energy savings from monitoring of substations. However, the data is used for energy and demand management by other ECOs. Therefore, the energy savings will not be accounted for here. There is no savings from power factor correction applications since Fort Campbell is not currently penalized in any of the billing records.

4.3.3 Maintenance Costs/Savings

Maintenance avoidance cost savings were estimated based on the reduced downtime and maintenance costs of the avoided electrical system failures prevented by early identification of problems by the UMCS/SCADA system. Since there is no statistical historical data available on the past failures of the substations, the savings will be estimated based on the value of equipment being monitored. See *Table 4.3.3.1* for quantification of savings.

Table 4.3.3.1
ECO 2 - ELECTRICAL SUBSTATIONS: COSTS/SAVINGS

#	Substation	Nameplate Rating MVA	Rated Voltage - KV	Feeder Breakers	Estimated Transformers Equipment Value
1	Clarksville Base	3 - .5/.67 10	67:12.47	1	$100,000
2	11th & Kansas	3 - 5/6.25 10	67:12.47	4	$250,000
3	Woodlawn Rd.	3 - 2.5 10	67:12.47	2	$150,000
4	46th & Kansas	3 - 5/6.25 10	67:12.47	3	$250,000
5	Campbell Airfield	3 - 1.67 10	67:12.47	2	$120,000
6	14th & Ohio	2 - 3.3/4.16 10 1 - 2.5 10	67:12.47	3	$200,000
7	29th & Ohio	3 - 5/6.26 10	67:12.47	7	$250,000
8	Flight Simulator Edgoten	4 - 5/6.26 10 4 - 20/26.6 10	67:12.47 88.9:39.8:13.2	4 2	$250,000

Assumptions:
Annual maintenance savings = 5% of transformer equipment value . . . . $ 78,500
Productivity man hour savings $127,000

Non-recurring savings:
Avoidance cost of electrical load study $120,000

4.3.4 Productivity Man Hour Savings

The productivity man hour savings result from the capability of the UMCS/SCADA system to provide total information on the electrical distribution system during power outages. Through the monitoring of individual electrical feeders, circuit protection devices and substation equipment, the UMCS/SCADA system is able to identify where the power outage occurred, which device tripped, and which circuit should be used to restore power. The information allows the maintenance personnel to respond to the power outage quickly and to safely restore power.

The savings calculation is based on a reduction in time of one hour for restoring power during an outage. The major power outages typically occur twice a year at Fort Campbell and potentially affect 25 percent of Fort Campbell's labor force (≈ 21,500 active duty personnel and ≈ 3,900 civilian personnel). Consequently, the total labor force man hours saved during two power outages per year

is 12,700 hours/year. The average hourly rate used in the calculation is $10/hr. See ECO 2 calculation sheet in Appendix C.

4.3.5 Non-Recurring Costs/Savings

Life-cycle costing guidelines require using a ten-year life for controls. A one-time cost of an electrical loads study, typically performed every five to ten years on the installation, is accounted for in the savings. Since the last study was performed in 1985, the savings will be captured in year five. See *Table 4.3.5.1* for the savings/costs summary for ECO 2.

Table 4.3.5.1

ECO 2 - ELECTRICAL SUBSTATIONS: COSTS/SAVINGS SUMMARY

Construction Cost (see cost estimate in Appendix C)	$999,104
Annual Energy /Savings / Costs	
Electrical Energy (MBtu/Yr)	0
Electrical Demand ($/Yr)	$0
Thermal Energy (MBtu/Yr)	
Natural Gas	0
Fuel Oil	$0
Non-Energy Savings / Costs Man-hour Productivity Saving Operation / Maintenance ($/Yr)	$127,000/yr $178,000/yr
Non-Recurring Savings / Costs Electrical System Load Study	$120,000 over 10 years

5.0 ECO 3: EMERGENCY GENERATORS

5.1 SYSTEM DESCRIPTION

Fort Campbell has approximately 45 emergency generator units. These generators are used to provide backup power to critical facilities and utility systems such as the command center, communications facility, water and waste plant facility, airfield support mission facility, etc. The generators found during the survey range from a three kilovolts generator which backs up airfield instrument devices, to a 750 kilovolts generator which backup the 160th Headquarters buildings. Most of the smaller generator units found were stripped-down package-type units with minimal controls and instrumentation. Some of the units are operated in manual mode only; no automatic transfer control devices are available. However, for the majority of the emergency generators, especially the larger units (>200 kW), the automatic transfer control and instrumentation sensors are available to be tied into the SCADA system. See *Table 5.1.1, Emergency Generator,* for location listing.

5.2 METHOD OF APPLICATION

Similar to the substation application, a circuit monitor will also be used for the monitoring and controlling of emergency generators. See *Figure 5.2.1* for system application diagram.

5.2.1 Point of Application

A circuit monitor will be used to monitor the generator output circuit breakers. The circuit monitor will be equipped with an input/output (I/O) module with main breaker auxiliary contacts and digital and analog I/O for generator control and for indication of status and alarming at the UMCS/SCADA computer stations. See *Table 5.2.1.1, Generator Metering and Monitoring Function Schedule.*

Table 5.1.1
EMERGENCY GENERATORS

	BLDG #	DESCRIPTION	CAPACITY (KW)	VALUE	SAVINGS
*1	6612	Boiling Spring	700	$125,000	$6,634
2	7543	M.A.R.S.	60	$18,000	$1,284
3	7541	Computer Center	125	$26,000	$1,684
4	7504	CAV Country Telephone	50	$15,000	$1,134
5	7703	LIft Station EEOD	60	$18,000	$1,284
6	7834	160th	100	$25,000	$1,634
7	7735	Lift Station at the Bridge	100	$25,000	$1,634
*8	7635	Sewage Plant	200	$33,000	$2,034
9	6801	Stockade	100	$25,000	$1,634
10	6643	Lift Station at Lake	60	$18,000	$1,284
11	PA6628	Sabre Night Lights	35	$14,000	$1,084
12	6632	Sabre Control Tower	60	$18,000	$1,284
13	6628	Sabre Telephone Bldg	50	$15,000	$1,134
14	OPM-1	Range 46 - repeater site	10	$8,000	$784
15	7187	Transmitter (SHAK)	60	$18,000	$1,284
16		Middle Marker	3	$4,000	$584
17		Outer Marker	3	$4,000	$584
18		Doppler Radar Site	80	$22,000	$1,484
19	2702	Commissary (out of service)	50	$15,000	$1,134
20	7180	P.A.R. - runway and taxi way	100	$25,000	$1,634
*21	1746	Water Treatment Plant	700	$125,000	$6,634
22	1565	Lift Station at Cole Park	100	$25,000	$1,634
23	2575	Fire Station #1	100	$25,000	$1,634
24	30	M.P. Station	12	$8,000	$784
*25	95	Signal Bld.	350	$46,000	$2,684
26	6226	42nd and Tennessee	125	$25,000	$1,634
27	3840	Lift Station at the Circle	12.5	$8,000	$784
28	7109	A.S.A.R.	100	$25,000	$1,634
29	7297	Glidescope	15	$10,000	$884
30	7169A	P.O.L. Libby	100	$25,000	$1,634
31	7168	Night Lighting Vault (inside)	100	$25,000	$1,634
32	7168	Night Lighting Vault (outside)	125	$25,000	$1,634
33	A7163	Base Operation	60	$18,000	$1,284
34	7160	Fire Station #3	50	$15,000	$1,134
35	7164	RAPCON	100	$25,000	$1,634
36	7156-WHT	White Telephone Bldg behind Hanger	80	$22,000	$1,484
37	A7140	Main P.O.L. Storage	60	$18,000	$1,284
38	7202	Receiver Site	30	$14,000	$1,084
*39	7227	160th Headquarters Bldg	750	$125,000	$6,634
40	7293	TACAN (out of service)	30	$14,000	$1,084
41	A7230	Destiny Runway Lights	30	$14,000	$1,084
42	7212	Destiny Control Tower	30	$14,000	$1,084
43	7221	Destiny Lift Station	50	$15,000	$1,134
44	A7201	Localizer	7.5	$8,000	$784
TOTAL EQUIPMENT VALUE				**$1,145,000**	

*Recommended for peak-shaving application.

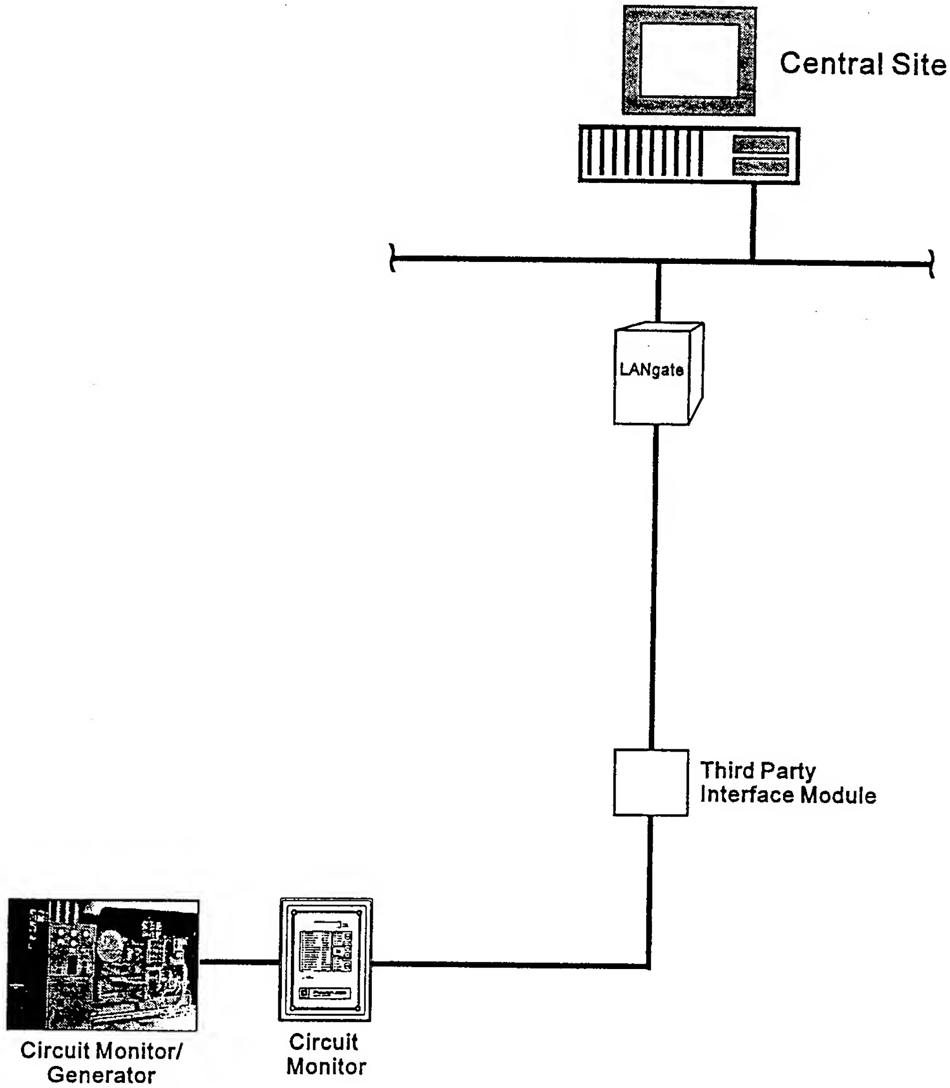


Figure 5.2.1

EMERGENCY GENERATOR MONITOR AND CONTROL

Table 5.2.1.1

GENERATOR METERING AND MONITORING FUNCTION SCHEDULE

Circuit monitor for monitoring of generator output breakers consists of Powerlogic Circuit Monitor Cat No. 3020 CM2050 and IOM18 8-point module with main breaker auxiliary contact and digital and analog I/O for generator control and for indication of status and alarming at the power monitoring computer station.

GENERATOR MONITOR: CM-G		
Metered/Monitored Value	Displayed at Equipment	Displayed at Computer
RMS Phase Current	X	X
Phase to Phase Volts	X	X
Phase to Neutral Volts	X	X
Real Power (kW)	X	X
Reactive Power (KVAR)	X	X
Apparent Power (KVA)	X	X
Power Factor (PF)	X	X
Energy (kWh)	X	X
Frequency	X	X
Peak Demand (kW)	X	X
Device Position (Open/Closed)		X
GENERATOR DIGITAL AND ANALOG I/0		
Control/Monitored Value	Displayed at Equipment	Displayed at Computer
Start/Stop		X
Fuel Level	X	X
Oil Pressure	X	X
Coolant Temperature	X	X
Battery Charge Level	X	X

5.2.2 Application Benefits

Centrally monitoring and controlling emergency generators with the SCADA system provides the following benefits:

- ⇨ Through the use of the SCADA system and its software programming, emergency generators can be programmed for load shedding applications. The monitored electrical demand information can be used to establish Fort Campbell's minimum demand level. The SCADA system can then control the emergency generators to come on-line and the loads to cycle off during the sharp period of commercial power usage. This should be implemented in conjunction with other load shedding schemes to gain maximum demand reduction benefits and minimize the power source switching effect through priority setting of the loads to be shed at different levels of demand.

- ⇨ It is important to properly manage and maintain emergency generators at Fort Campbell since they play an important role in maintaining Fort Campbell's mission capability. The SCADA system can be used to manage an emergency generator's maintenance and operation. The SCADA system will be used to monitor the status of the generators during stand-by and during operation. The SCADA operator can perform remote testing, fuel level reading, and monitoring of critical alarms during its operation.(See *Table 5.2.1.1, Generator Metering and Monitoring Function Schedule*) This can be quantified into labor and equipment maintenance savings.

5.3 ECONOMIC ANALYSIS

5.3.1 Investment Costs

Investment cost estimating was performed for the monitoring of all emergency generators. The common components of the communications network including head-end computer equipment, post-wide fiber optic cabling, wireless modems, software and programming were priced separately. The total cost of the common components was then divided among the systems on the network based on the number of communication nodes.

5.3.2 Energy Costs/Savings

There is no direct energy savings from monitoring of emergency generators. However, the generator can be controlled and managed to save on electrical demand. It is highly recommended that the emergency generators marked with an asterisk (*) in Table 5.1.1 be utilized for a demand management scheme (peak shaving application). The potential demand reduction achievable from these generators is 2,700 kilowatts at $11.78 per kilowatt hour for a savings of $381,672 annually. These generators should only be required to run for short periods of time, typically less than 500 hours per year. Accordingly, some of the savings will be offset by a fuel cost of $78,390 per year. In order to save fuel and satisfy emergency generator test requirements, it is recommended that generator testing be performed when peak demand periods occur.

5.3.3 Maintenance Costs/Savings

Maintenance avoidance cost savings were estimated based on the reduced downtime and maintenance costs of the avoided electrical system failures prevented by early identification of problems by the UMCS/SCADA system. Since there is no statistical historical data available on the past failures of the generators, the maintenance savings will be based on the value of the equipment. It is conservatively assumed to be 5 percent in the calculation. See *Table 5.3.3.1* for quantification of savings factors. Also, see the ECO 3 calculation sheet in *Appendix C.*

Table 5.3.3.1

EMERGENCY GENERATOR SAVINGS CALCULATION FACTORS

Expected Labor Savings	
Generator Status Check:	1 mh/mo
Reduce In-Service and Out-Of-Service Call Response:	1 mh/mo
Remote On-Line, Off-Line Test:	4 mh/yr

Preventive Maintenance Savings Assumptions:

1. One failure prevented per year.
2. Equipment damage avoidance cost is 5 percent of the total equipment value.
3. Ten labor hours are saved per failure avoided.

5.3.4 Non-Recurring Costs/Savings

No non-recurring costs or savings were considered for this ECO. See *Table 5.3.4.1* for savings/costs summary for ECO 3.

Table 5.3.4.1

ECO 3 - EMERGENCY GENERATORS: COSTS/SAVINGS SUMMARY

Construction Cost (see cost estimate in Appendix C)	$381,927
Annual Energy /Savings / Costs	
Electrical Energy (MBtu/Yr)	0
Electrical Demand ($/Yr)	$381,672/yr.
Thermal Energy (MBtu/Yr)	
Natural Gas	0
Fuel Oil	- 10,332 MBtu/yr.
Non-Energy Savings / Costs Operation / Maintenance ($/Yr)	$74,146/yr.
Non-Recurring Savings / Costs	$0

6.1 SYSTEM DESCRIPTION

Fort Campbell's potable water is obtained from the Boiling Springs Pumping Station where three 300 horsepower pumps pump raw water about two miles to the water treatment facility located at Fort Campbell. A backup source of raw water is the Red River Pump Station, located approximately eight miles south of the Post.

Upon reaching the treatment plant, the water is treated and stored in two clear wells with a total capacity of 1.5 millions of gallons. From the clear wells, the water is pumped to five storage towers with a total capacity of 2.75 MG, by four high service pumps. According to fire regulations, elevated storage capacity cannot drop below 50 percent at any time. The average daily throughput of the plant is 4.4 MGD, and usage peaks in the summer at about 5.9 MGD.

The high service pumps and the Boiling Springs pumps are the primary energy users of the system. An existing variable frequency drive at Boiling Springs can control the pump flow of any of the three pumps by varying the speed of the pump's motors.

This and all other process controls of the water system are currently performed manually by the plant operators. *Figure 6.1.1* is a schematic diagram of the major components of the water system.

6.2 METHOD OF APPLICATION

The proposed system consists of: a computer interface for the operator located at the water plant; pressure and level sensors in the elevated storage system and clear wells; and DDC control modules located at the Boiling Springs station, the Red River station and the high service pump room of the treatment plant.

In addition, a variable frequency drive would be installed on the 300 horsepower high service pumps located at the plant. By adding three FM transceivers, one each at Boiling Springs, Red River, and the treatment plant, communication over the long distances between the sites is allowed.

Utilizing the new variable frequency drive in conjunction with the existing drive at Boiling Springs, and controlling both sets of pumps through the UMCS, allows operators to have the information necessary to operate the plant in a safer and more efficient manner than is now possible. Due to infrequent use,

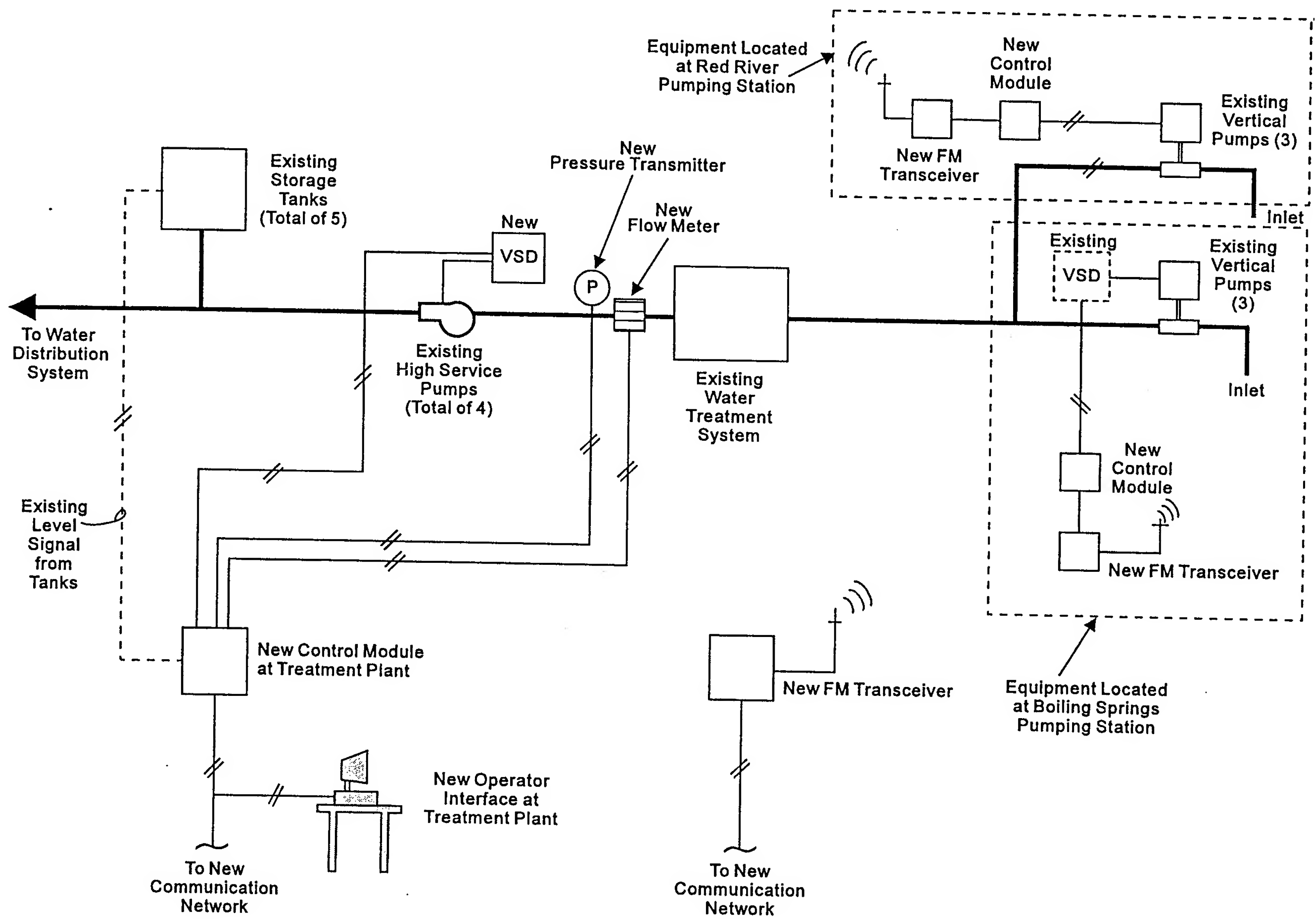


Figure 6.1.1

WATER TREATMENT PLANT SCHEMATIC

variable frequency drives were not considered for the Red River Station. However, the Red River Station is connected to the UMCS to enable remote operation and monitoring.

Along with more automated operations comes the opportunity to save dollars by running the large pumps during off-peak hours as much as possible. Calculations show that by operating on the pumping schedule indicated in *Table 6.2.1*, excessive electrical demand charges are avoided, while storage capacity never drops below 55 percent.

Table 6.2.2 lists the facilities considered for this ECO, the number of control points required, and the costs and savings used in the analysis. Calculations, cost estimates and life-cycle cost analyses for this ECO are found in *Appendix C.*

6.2.3 Economic Analysis

6.2.3.1 Investment Costs

Since investment cost estimating was performed considering the water system as a subsystem of the UMCS, pricing includes all components required for water system control; such as, control modules, sensors, actuators and wiring. Components common to all subsystems of the UMCS such as the head-end computer network, post-wide fiber optic cabling, software and programming were priced separately. The total cost of the common components was then divided among the buildings based on the number of points per building and this shared cost was added to each individual building's cost estimate. Therefore each individual building estimate shares the actual cost of the equipment which is necessary to the functioning of the whole UMCS but is not directly associated with the individual building cost.

6.2.3.2 Energy Costs/Savings

Energy savings were determined by using data obtained from water plant charts for the day of Thursday, June 1,1995. The hourly demand on the plant was established and the proposed pumping schedule is shown in *Table 6.2.1.* The savings for operating on this schedule are then established by the reduction of the electrical demand. By pumping at a 50 percent reduced flow rate during peak demand hours, a 65 percent reduction in pumping horsepower is achieved in accordance with pumping laws.

Table 6.2.1

PUMPING SCHEDULE

Pump Time	Tank Water Level (Mgal)	Usage Rate (Gal/hr)	Pump Station Status	Output (Gal/hr)
Midnight	1.85	104,000	1 @ 100% Flow	210,000
1 a.m.	1.96	104,000	1 @ 100% Flow	210,000
2 a.m.	2.07	104,000	2 @ 100% Flow	420,000
3 a.m.	2.18	104,000	2 @ 100% Flow	420,000
4 a.m.	2.49	104,000	1 @ 53% Flow	112,500
5 a.m.	2.75	112,500	1 @ 100% Flow	210,000
6 a.m.	2.75	116,700	1 @ 56% Flow	116,700
7 a.m.	2.75	221,000	1 @ 100% Flow	210,000
8 a.m.	2.74	333,000	1 @ 100% Flow	210,000
9 a.m.	2.62	292,000	1 @ 100% Flow	210,000
10 a.m.	2.53	250,000	1 @ 50% Flow	105,000
11 a.m.	2.28	271,000	1 @ 50% Flow	105,000
Noon	2.11	271,000	1 @ 50% Flow	105,000
1 p.m.	1.95	230,000	1 @ 50% Flow	105,000
2 p.m.	1.82	208,000	1 @ 50% Flow	105,000
3 p.m.	1.72	208,000	1 @ 50% Flow	105,000
4 p.m.	1.62	208,000	1 @ 50% Flow	105,000
5 p.m.	1.52	208,000	1 @ 100% Flow	210,000
6 p.m.	1.52	208,000	1 @ 100% Flow	210,000
7 p.m.	1.52	208,000	1 @ 100% Flow	210,000
8 p.m.	1.52	208,000	1 @ 100% Flow	210,000
9 p.m.	1.52	167,000	1 @ 100% Flow	210,000
10 p.m.	1.56	125,000	1 @ 100% Flow	210,000
11 p.m.	1.64	104,000	1 @ 100% Flow	210,000
12 a.m.	1.75	104,000	1 @ 100% Flow	210,000

Table 6.2.2
FACILITIES CONSIDERED FOR ECO 4

Facility	Control Points Required	Energy Savings ($)	Operational Savings ($)
Treatment Plant	25	11,000	7,300
Boiling Springs Pumping Station	15	11,000	7,300
Red River Pumping Station	15	0	0

6.2.3.3 Operational Costs/Savings

Savings were based on an estimated average savings of 1 man-hour per day due to automation of control functions. The savings are conservative since they consider only the savings associated with actual plant operations and not reduced maintenance and troubleshooting time.

6.2.3.4 Non-Recurring Costs/Savings

No non-recurring costs or savings were considered for this ECO. See *Table 6.2.3.4.1* for the savings/costs summary for ECO 4.

Table 6.2.3.4.1 ECO 4 - WATER SYSTEM: COSTS/SAVINGS SUMMARY	
Construction Cost (see cost estimate in Appendix C)	$62,700
Annual Energy /Savings / Costs	
Electrical Energy (MBtu/Yr)	0
Electrical Demand ($/Yr)	$55,000/yr.
Thermal Energy (MBtu/Yr)	
Natural Gas	0
Fuel Oil	0
Non-Energy Savings / Costs Operation / Maintenance ($/Yr)	$14,600/yr.
Non-Recurring Savings / Costs	$0

7.0 ECO 5: SEWAGE TREATMENT SYSTEM

7.1 EXISTING SYSTEM

Fort Campbell treats all of its raw sewage independent of the local municipal sewage treatment facility. The sewage treatment facility is located on the south side of the Post at Building 7636. The sewage is pumped to the treatment facility from 33 different sewage lift stations located throughout the Post. These lift stations typically are small packaged units utilizing a small sump. A float mechanism monitors the level in the sump and activates the pump when the float reaches a preset level. *Figure 7.1.1* is a schematic representation of a typical lift station used at Fort Campbell.

The pumps range from 2 to 30 horsepower at the lift stations; most are in the 2 to 5 horsepower range. *Table 7.1.1* lists the lift station locations, the area served by each station, the number of pumps and the motor horsepower of each pump.

Currently the plant operators monitor system operations by visual inspections and trouble calls. Each lift station has a local visual and audible alarm in case of sump overflow and bypass flow. However, in remote locations the alarms may go unnoticed for days due to manpower shortages.

State wastewater regulations require that all sewage that bypasses treatment must be reported to state authorities as to quantity and duration. With Fort Campbell's current treatment facilities, quantities and duration can not be accurately measured. At this time, operators have no accurate means of reporting bypass flows which occur. Potential fines for dumping untreated sewage could run into thousands of dollars should the Fort ever be monitored by wastewater authorities.

7.2 PROPOSED UMCS/SCADA SYSTEM CONNECTION

The proposed system consists of a computer interface for the operator located at the sewage treatment plant which monitors the plant and all 33 lift stations. A new flow meter installed in the bypass line at each lift station monitors flow which is bypassing the lift station in trouble situations. This flow is recorded at the treatment plant for both quantity and duration.

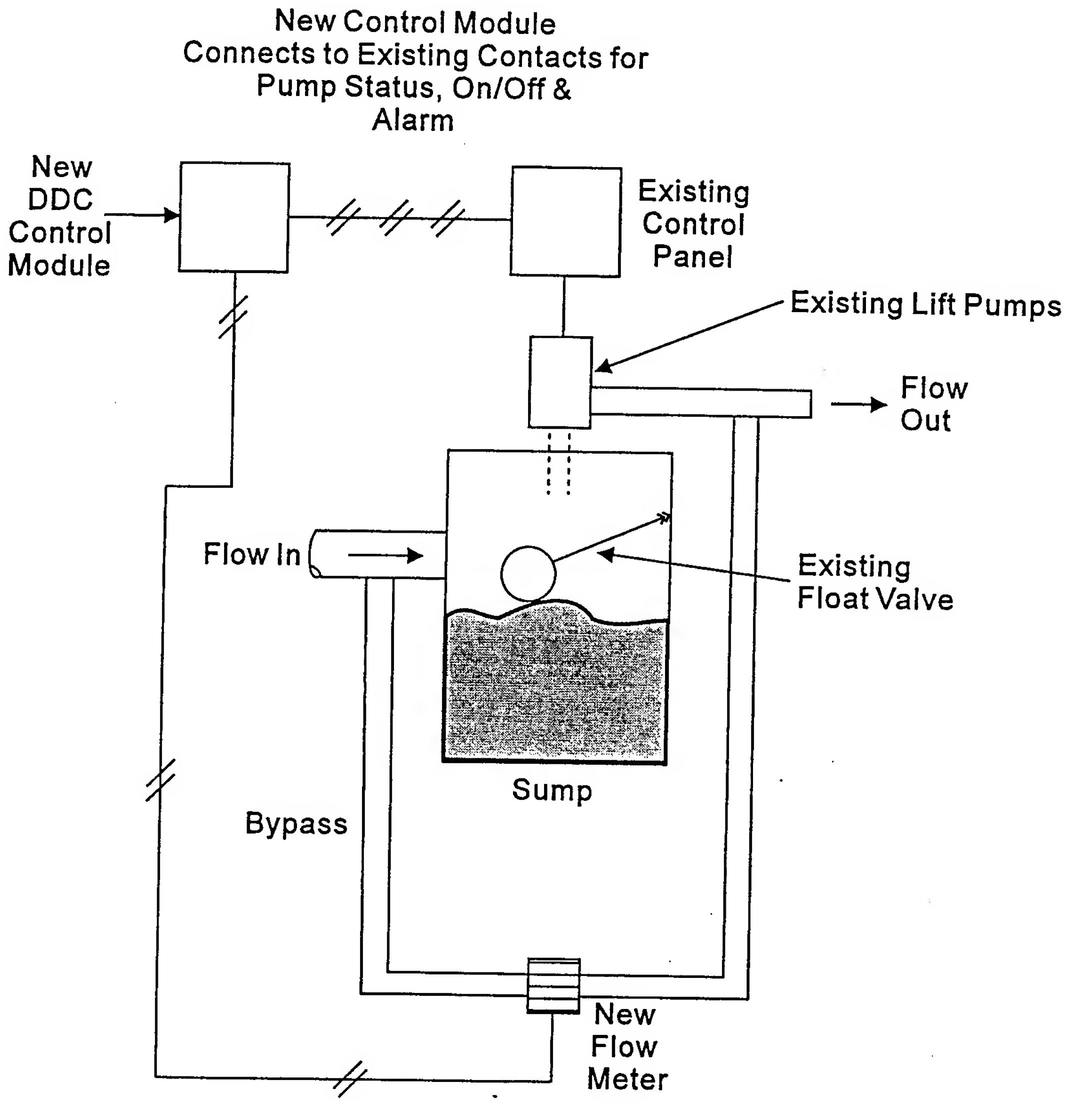


Figure 7.1.1

SEWAGE LIFT STATION SCHEMATIC

(Typical for 35)

Table 7.1.1

SEWAGE LIFT STATIONS

Number		Description	Horsepower
1	7081	311th MI Motor Pool	2
2	1043	Drennan Park (441A)	2-7.5
3	1199	Gate 2	2-5
4	1230	Alaska Av & 11th St.	2-7.5
5	1565	Cole Park	2-5
6	1602	Water Plant	2-7.5
7	3840	Lee Village (Traffic Circle)	2-3
8	4355	Pierce Village	2-20
9	4964	Gate 5	2-5
10	5005	Hammond Heights	3-7.5
11	5225	Recycle Center	2
12	A6088	Range Central	5
13	6094	Range Road	2-.75
14	6226	5th Special Forces	2-5
15	6643	Old Rod & Gun club	1-20, 1-30
16	A6643	New Road & Gun club	2-.5
17	7140	Bulk Fuel Storage	2
18	7144	Oasis Warehouses	2
19	7165	Airbase Transient Alert Bldg.	2-2
20	7172	Old Air Base	2-7.5
21	7221	New Airbase Lift Station	3-10
22	7240	Warehouse	2
23	7271	Avum Hanger	1-10, 1-3
24	7604	Forestry	2
25	7606	Pesticide	2
26	7703	Georgia Road	3-20
27	7735	Ohio Road	2-10
28	7862	Installation Maintenance	2
29	PSLS 11	1100 Block (1141-1143) (1149-1151) (1164-1166) (1186-1188)	2
30	PSLS 38	3800 Block (3809-3811) (3810-3812) (3819-3821) (3838-38369)	2
31	PSLS 45	4500 Block (4519-4521) (4550-4552) (4554-4556)	2
32	PSLS 46	4600 Block (4688-4690) (4692-4694)	2
33	PSLS 49	4900 Block (4920-4922) (4924-4926) (4928-4930) (4938-4940) (4945-4947) (4948-4950) (4965-4967) (4978-4980) (4982-4984) (4973-4975)	2

Each lift station will require a DDC control module which connects to the local alarm panel, bypass flow meter and pump control panel. In this way system operators are notified immediately of pump failures, overflows and other trouble codes. In addition, individual pumps may be started and stopped from the plant rather than having to send an operator to the station for manual start/stop procedures.

Where the proposed fiber optic communication trunk line is nearby to a lift station the control module signals are wired to the fiber optics system directly. For remote lift stations an FM transceiver is used to send communication signals to the UMCS/SCADA master system where it is linked to the communications network.

Operating through the UMCS, operators will have the information necessary to operate the plant and lift stations in a safer and more efficient manner than is now possible.

Calculations, cost estimates and life-cycle cost analyses for this ECO are found in *Appendix C.*

7.3 INVESTMENT COSTS

For investment cost estimating the sewage treatment system was considered as a subsystem of the UMCS. Therefore pricing includes all components required for the treatment system control, such as control modules, sensors, actuators and wiring. Components common to all subsystems of the UMCS such as the head-end computer network, post-wide fiber optic cabling, software and programming were priced separately. The total cost of the common components was then divided among the buildings and this shared cost was added to each individual building's cost estimate. Therefore the sewage treatment system estimate shares the actual cost of the equipment which is necessary to the functioning of the whole UMCS but is not directly associated with the individual treatment system cost.

7.4 ENERGY COSTS/SAVINGS

No energy costs or savings will result from the implementation of this ECO.

7.5 OPERATIONAL COSTS/SAVINGS

Savings were based on an estimated average savings of one man-hour per day due to automation of control functions. The savings are conservative since they consider only the savings associated with actual plant operations and not reduced maintenance and troubleshooting time.

7.6 NON-RECURRING COSTS/SAVINGS

No non-recurring costs or savings were considered for this ECO. See *Table 7.6.1* for the savings/costs summary for ECO 5.

Table 7.6.1

ECO 5 - SEWAGE TREATMENT SYSTEM:
COSTS/SAVINGS SUMMARY

Construction Cost (see cost estimate in Appendix C)	$205,000
Annual Energy /Savings / Costs	
Electrical Energy (MBtu/Yr)	0
Electrical Demand ($/Yr)	$0
Thermal Energy (MBtu/Yr)	0
Natural Gas	0
Fuel Oil	
Non-Energy Savings / Costs Operation / Maintenance ($/Yr)	$14,600/yr.
Non-Recurring Savings / Costs	$0

8.0 ECO 6: Remote Metering System

8.1 SYSTEM DESCRIPTION

A majority of Fort Campbell's facilities lack utility metering except for the reimbursable customers' facilities. Currently these facilities are read visually and are manually recorded in a log book by the customers once a month. The readings are then reported to the installation utility manager who, in turn, manually records them onto the spreadsheet for billing calculation. The Utility Management Office sends a meter reading person out once a year to verify the accuracy of the customers' past reading values. The whole process can be simplified with the remote and centralized reading of the utility meters.

8.2 METHOD OF APPLICATION

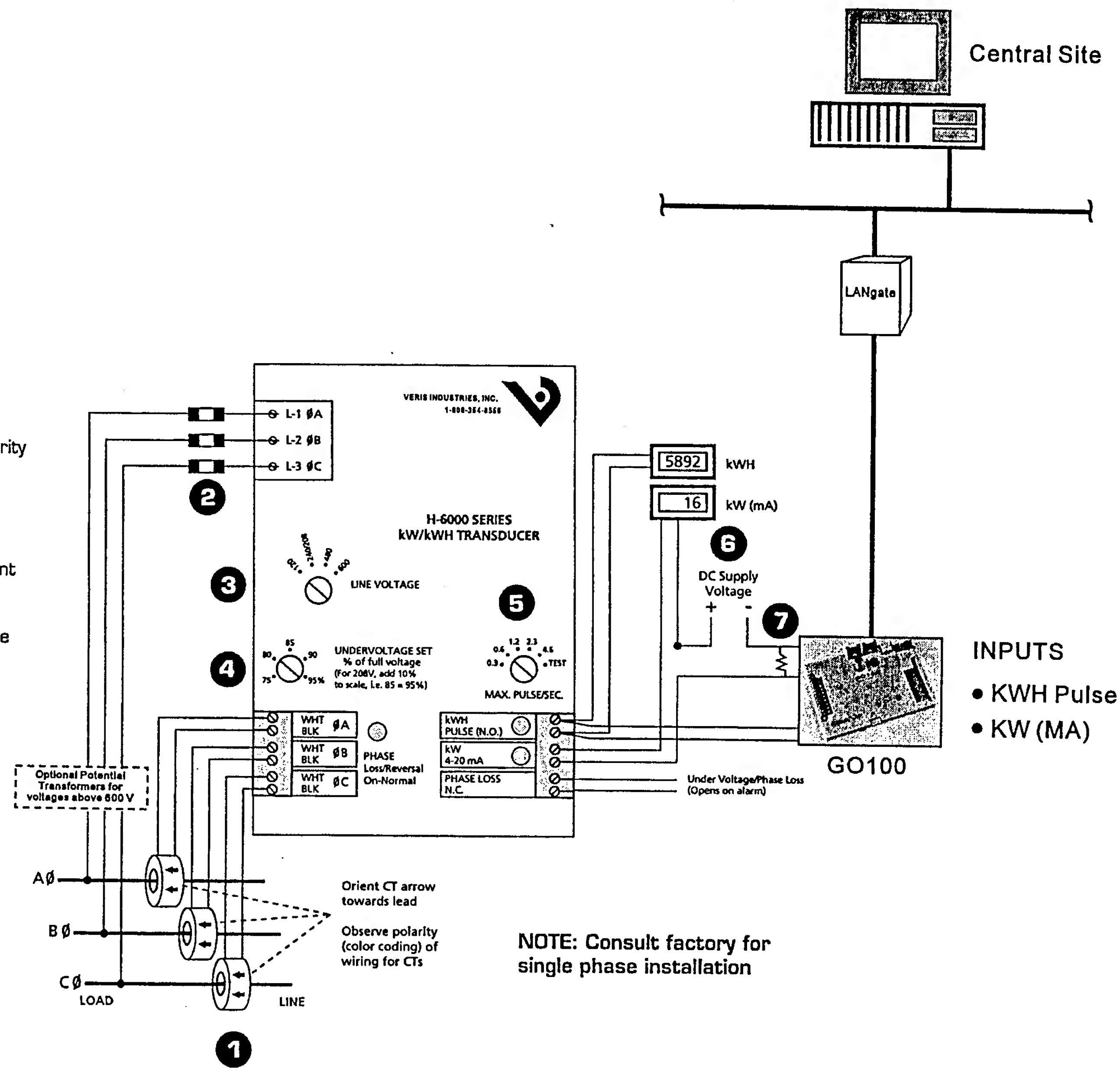
8.2.1 Points of Application

There are approximately sixty-four reimbursable customer sites to be monitored at Fort Campbell. Sixty-four kilowatt/kilowatt-hour transducers will be installed at each of the sites to remotely monitor the electrical energy consumption, and forty-one gas flow meter/transducers will be installed to monitor the natural gas consumption. Some facilities do not have gas service. See *Figure 8.2.1.1* for system connection. See *Table 8.2.1.1* and *Table 8.2.1.2* for a reimbursable customers points list.

8.2.2 Application Benefits

The SCADA system provides the capability to automatically read the meter, record consumption data, and perform billing calculations directly from the computer stations. The SCADA software can be programmed to poll meter readings and transfer data to the spreadsheets that calculate billing according to a set schedule rate. See *Table 8.2.2.1* for automatic billing calculation applications.

1. Veris Safe Split Core CTs-1.0 V output. Orient CT arrow towards load. Observe polarity (color coding) of wiring for CTs
2. Fuse or breaker per NEC
3. Select desired line voltage up to 600 VAC
4. Undervoltage/phase loss percentage set-point
5. Pulse rate selection per automation system
6. Non-polarity sensitive 4-20 mA loop. Observe panel polarity
7. For voltage output, install resistor at automation panel. Consult factory for installation requirements



NOTE: Consult factory for single phase installation

Figure 8.2.1.1

REMOTE METERING - ELECTRIC

Table 8.2.1.1

REIMBURSABLE CUSTOMERS ELECTRIC METERING POINTS LIST

Description		Annual Savings
1	Army Travel Campground	$216
2	Army Travel Bldg 6621	$216
3	American Federation of Government Employees Bldg 2110	$216
4	Army Guest House Bldg 2601	$216
5	Club	$216
6	Club Volleyball Court	$216
7	Westbyrd, Inc. Bldg 2265	$216
8	Unique Cleaning Service	$216
9	TN National Guard	$216
10	Taylor Bus Sales, Inc.	$216
11	Riding Stable Bldg 6601	$216
12	Riding Stable Bldg 6602	$216
13	Resale Stables Bldg 6603	$216
14	Kennel Bldg 6617	$216
15	Stable Rent Bldg 6619	$216
16	Hay Barn Bldg 6619A	$216
17	Indoor Kennel Bldg 6620	$216
18	Sportsman Lodge	$216
19	U.S. Post Office Bldg 91	$216
20	Parcabale, Inc. Bldg 923	$216
21	Parachute Club Bldg 2519	$216
22	Fort Campbell Officer's Club Bldg 1501	$216
23	CL-U, 621st AMOG CAAF	$216
24	NCO Club	$216
25	NationsBank Of KY (29th & Michigan)	$216
26	MRM Investment Co.	$216
27	Louisville Corps of Engineers Bldg 2180	$216
28	Hooper Bowling Center	$216
29	Marion F. Kadunc (Greyhound Lines)	$216
30	Golf Course	$216
31	Maintenance Bldg 1568	$216
32	Maintenance Bldg 1603	$216
33	Golf Course	$216
34	Garner Bowling Lanes	$216
35	Lincoln School	$216
36	Wassom Middle School	$216
37	(2 Meters)	$216
38	Jackson School	$216
39-41	3 Trailers	$648

Table 8.2.1.1

REIMBURSABLE CUSTOMERS ELECTRIC METERING POINTS LIST

Description		Annual Savings
42	Equipment Checkout Bldg 5658	$216
43	Field OFC Defense	$216
44-45	Defense Printing Office Bldg 2611/2615	$432
46	Credit Union	$216
47	Commissary Bldg 2702	$216
48	Clarksville Limousine Service	$216
49	Champion sports Club	$216
50	CCT Services	$216
51	Bldg 2699	$216
POST EXCHANGE		
52	92 KY SER Station	$216
53	Hospital PX	$216
54	Hospital Bar S	$216
55	3000 PX Shopette Ky	$216
56	808-810 PX Warehouse	$216
57	812 "4" Seasons	$216
58	TN Shopette 2129 & Laundry	$216
59	PX Mall Bldg 2840	$216
60	3108 Vend/Warehouse	$216
61	3958 PX & SNK	$216
62	5660 TN Service Station	$216
63	MCC Phone CTR Bldg 5701	$216
64	6140 PX #5	$216
65	6722 PX #3	$216
66	6902 PX #7	$216
67	7163 Snack Bar	$216
68	Main Store Basement 98	$216
69	Bldg 96 Class Six	$216
70	4190 LV Shopette	$216
71	5703 Burger King	$216
72	3105 PX Admin/Maint	$216
TOTAL REMOTE METER READING SAVINGS		$15,552

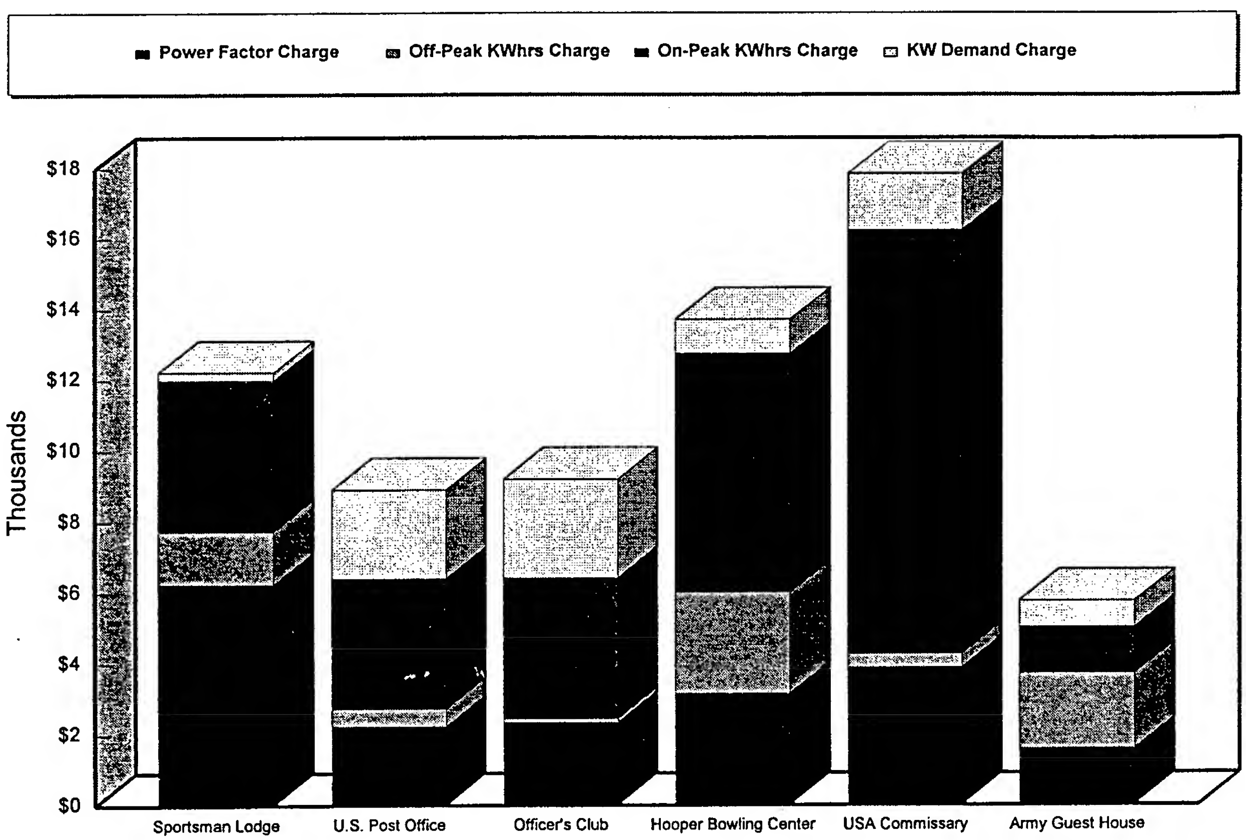
	Table 8.2.1.2 REIMBURSABLE CUSTOMERS GAS METERING POINTS LIST	
	Description	Annual Savings
1	American Federation of Govt. Employees Bldg 2110	$216
2	Army Guest House Bldg 2601	$216
3	Club Volleyball Court	$216
4	Westbyrd, Inc. Bldg 2265	$216
5	Unique Cleaning Service	$216
6	TN National Guard	$216
7	Taylor Bus Sales, Inc.	$216
8	U.S. Post Office Bldg 91	$216
9	Ft. Campbell Officer's Club Bldg 1501	$216
10	CL-U, 621st AMOG CAAF	$216
11	NCO Club	$216
12	NationsBank of KY (29th & Michigan)	$216
13	MRM Investment Co	$216
14	Louisville Corps of Engineers Bldg 2180	$216
15	Hooper Bowling Center	$216
16	Marion F. Kadunc (Greyhound Lines)	$216
17	Garner Bowling Lanes	$216
18	Lincoln School	$216
19	Wassom Middle School	$216
20	(2 Meters)	$216
21	Equipment Checkout Bldg 5658	$216
22	Field OFC Defense	$216
23	Defense Printing Office Bldg 2611/2615	$432
24	Credit Union	$216
25	Commissary Bldg 2702	$216
26	Clarksville Limousine Service	$216
27	Champion Sports Club	$216
28	CCT Services	$216
29	BLDG 2699	$216
	POST EXCHANGE	
30	92 KY SER Station	$216
31	3000 PX Shoppette Ky	$216
32	812 "4" Seasons	$216
33	TN Shoppette 2129 & Laundry	$216
34	PX Mall Bldg 2840	$216
35	3108 Vend/Warehouse	$216
36	MCC Phone CTR Bldg 5701	$216
37	7163 Snack Bar (EST)	$216
38	4190 LV Shoppette	$216
39	4190 LV Launderette	$216
40	5703 Burger King	$216
41	3105 PX Admin/Maint	$216
	TOTAL REMOTE METER READING SAVINGS	$9,072

Table 8.2.2.1

AUTOMATIC BILLING CALCULATIONS

The following table and bar chart illustrate how the billing module can provide coincident demand, power factor, and cost data by tenant units.

Department	*On-Peak MWhrs*	*ON-Peak MWhrs Charge*	*Off-Peak Mwhrs*	*Off-Peak MWhrs Charge*	*Peak MW Demand*	*MW Demand Charge*	*Average Power Factor*	*Power Factor Charge*	*Total Department Billing*
Sportsman Lodge	439	$6,250.50	105	$1,500.25	298	$4,250.50	0.845 Lag	$224.50	**$12,225.75**
U.S. Post Office	157	$2,234.15	35	$500.15	258	$3,675.24	0.740 Lead	$2,512.91	**$8,922.45**
Officer's Club	165	$2,350.50	7	$95.95	280	$3,990.45	0.642 Lead	$2,778.85	**$9,215.75**
Hooper Bowling Center	222	$3,162.40	200	$2,847.80	474	$6,750.85	0.943 Lag	$964.70	**$13,725.75**
USA Commissary	273	$3,885.50	28	$395.40	841	$11,979.45	0.901 Lag	$1,602.55	**$17,862.90**
Army Guest House	112	$1,592.45	149	$2,125.15	93	$1,320.50	0.832 Lag	$737.50	**$5,775.60**
TOTAL	*1,368*	$19,475.50	524	$7,464.70	2,244	$31,966.99	0.869 Lag	$8,821.01	$67,728.20



8.3 ECONOMIC ANALYSIS

8.3.1 Investment Costs

Investment cost estimating was performed for the monitoring of all electrical and natural gas meters of Fort Campbell's reimbursable customers. The common components of the communication network including head-end computer equipment, post-wide fiber optic cabling, wireless modems, software and programming were priced separately. The total cost of the common components was then divided among the systems on the network based on the number of communication nodes.

8.3.2 Energy Costs/Savings

There is no direct energy savings for this ECO.

8.3.3 Labor Costs/Savings

The economic benefit for this ECO comes from the labor savings resulting from not having to locally read individual sites and not having to manually log, transfer, and calculate consumption data and cost data for customers' billings. See *Table 8.3.3.1* below for the calculation of savings.

Table 8.3.3.1

ECO 6 - REMOTE METERING SYSTEM: COSTS/SAVINGS

Meter Reading & Reporting Man-hours:	½ mh/meter/mo
Billing Calculation:	1 mh/customer/mo
Labor Rate:	$12/mh

Total Annual Savings per Metering Point (TAS)

TAS = (½ + 1) mh/meter/mo * $12/mh * 12 mo/yr = $216/meter/yr

8.3.4 Non-Recurring Costs/Savings

No non-recurring costs or savings were considered for this ECO. See *Table 8.3.4.1* for the savings/costs summary for ECO 6.

Table 8.3.4.1

ECO 6 - REMOTE METERING SYSTEM: COSTS/SAVINGS SUMMARY

Construction Cost (see cost estimate in Appendix C)	$570,922
Annual Energy /Savings / Costs	
Electrical Energy (MBtu/Yr)	0
Electrical Demand ($/Yr)	$0
Thermal Energy (MBtu/Yr)	
Natural Gas	0
Fuel Oil	0
Non-Energy Savings / Costs Operation / Maintenance ($/Yr)	$24,408/yr.
Non-Recurring Savings / Costs	$0

9.0 ECO 7: UNDERGROUND STORAGE TANKS

9.1 SYSTEM DESCRIPTION

There are 37 underground storage tanks at Fort Campbell that are regulated under 40 CFR, Parts 280-281. These tanks are located at 20 sites on post and vary in capacity between 550 and 20,000 gallons. These tanks contain gasoline, diesel fuel and waste oil. The tanks are either single wall or double wall construction. *Table 9.1.1* summarizes the capacity and construction of the regulated underground storage tanks. In order to comply with 40 CFR 280-281, these tanks must have spill and overfill protection, corrosion protection, and leak detection. Leak detection methods used at Fort Campbell include tank level monitoring and interstitial leak sensors. By regulation, leak detection must be checked monthly, at a minimum.

9.2 PROPOSED SYSTEM

The proposed tank monitoring requires Automated Logic G 0100 modules at each of the 20 tank locations and X 080 expansion modules at three locations. These modules have 10 universal inputs that can be connected to leak sensors, lever monitoring probes, overfill alarms and sump pump alarms. The expansion modules add eight additional universal inputs in areas that require more than 10 inputs. If connected to the post SCADA system, the alarms and leak detection devices can be monitored at a central location. *Figure 9.2.1* shows a typical system component diagram for underground storage tanks. *Table 9.2.1* gives the monitoring schedule for the underground storage tanks at Fort Campbell.

9.2.1 Economic Analysis

The total cost to connect the underground storage tank leak detection and alarm system is approximately $27,000. This includes the cost of twenty G0100 modules and three X 080 expansion modules. These modules will be installed near the existing control panel and connected to the SCADA system. The cost of the monthly checks and services will be reduced by approximately $1,600 per year, since all sensor signals can be read at a central location. Other benefits to the automated monitoring and alarm system that are not easily quantified include:

1) reduced clean up cost due to leaks
2) reduced potential for environmental contamination
3) reduced health safety and fire risk

These benefits result from immediate identification of a leak or an overfilled tank.

Table 9.1.1

FORT CAMPBELL UMCS/SCADA
TANK MONITORING EQUIPMENT LIST

Description	Capacity	Monitor Type	Construction
Bus Garage #1	10,000 gal	Veeder Root TLS-250i	Single-Wall
Bus Garage #2	10,000 gal	Veeder Root TLS-250i	Single-Wall
Marshall Schools #3	1000 gal	Gilbarco EMC	Double-Wall
Marshall Schools #4	1000 gal	Gilbarco EMC	Double-Wall
92-7	20,000	Gilbarco EMC	Double-Wall
92-8	20,000	Gilbarco EMC	Double-Wall
92-9	8,000	Gilbarco EMC	Double-Wall
92-10	550	Gilbarco EMC	Double-Wall
611-3		Gilbarco EMC	
611-4		Gilbarco EMC	
750-2	1,000	Gilbarco EMC	Double-Wall
754-2	2,000	Gilbarco EMC	Double-Wall
1746-1	15,000	Gilbarco EMC	Single-Wall
2129-1	12,000	Veeder Root TLS-350	Double-Wall
2129-2	12,000	Veeder Root TLS-350	Double-Wall
2129-3	12,000	Veeder Root TLS-350	Double-Wall
3000-1	10,000	Tidel Systems GTM-1	Double-Wall
3000-2	10,000	Tidel Systems GTM-1	Double-Wall
3000-3	10,000	Tidel Systems GTM-1	Double-Wall
5115-3	10,000	Gilbarco EMC	Double-Wall
5115-4	10,000	Gilbarco EMC	Double-Wall
5660-6	12,000	Gilbarco EMC	Double-Wall
5660-7	12,000	Gilbarco EMC	Double-Wall
5660-8	20,000	Gilbarco EMC	Double-Wall
6247-1	1,000	Bindicator Model GTX-1 petrometer Model 20	Single-Wall
6327-3	12,000	Gilbarco EMC	Double-Wall
6327-4	12,000	Gilbarco EMC	Double-Wall
6612-1	15,000	Gilbarco EMC	Single-Wall
6636-1	1,000	Gilbarco EMC	Single-Wall
6636-2	1,000	Gilbarco EMC	Single-Wall
6806-1	1,000	Gilbarco EMC	Single-Wall
6823-1	1,000	Gilbarco EMC	Single-Wall
7014-1	1,000	Gilbarco EMC	Single-Wall
7051-4	8,000	Gilbarco EMC	Double-Wall
7051-5	8,000	Gilbarco EMC	Double-Wall
7051-6	4,000	Gilbarco EMC	Double-Wall
7141A-2	5,000	Gilbarco EMC	Double-Wall

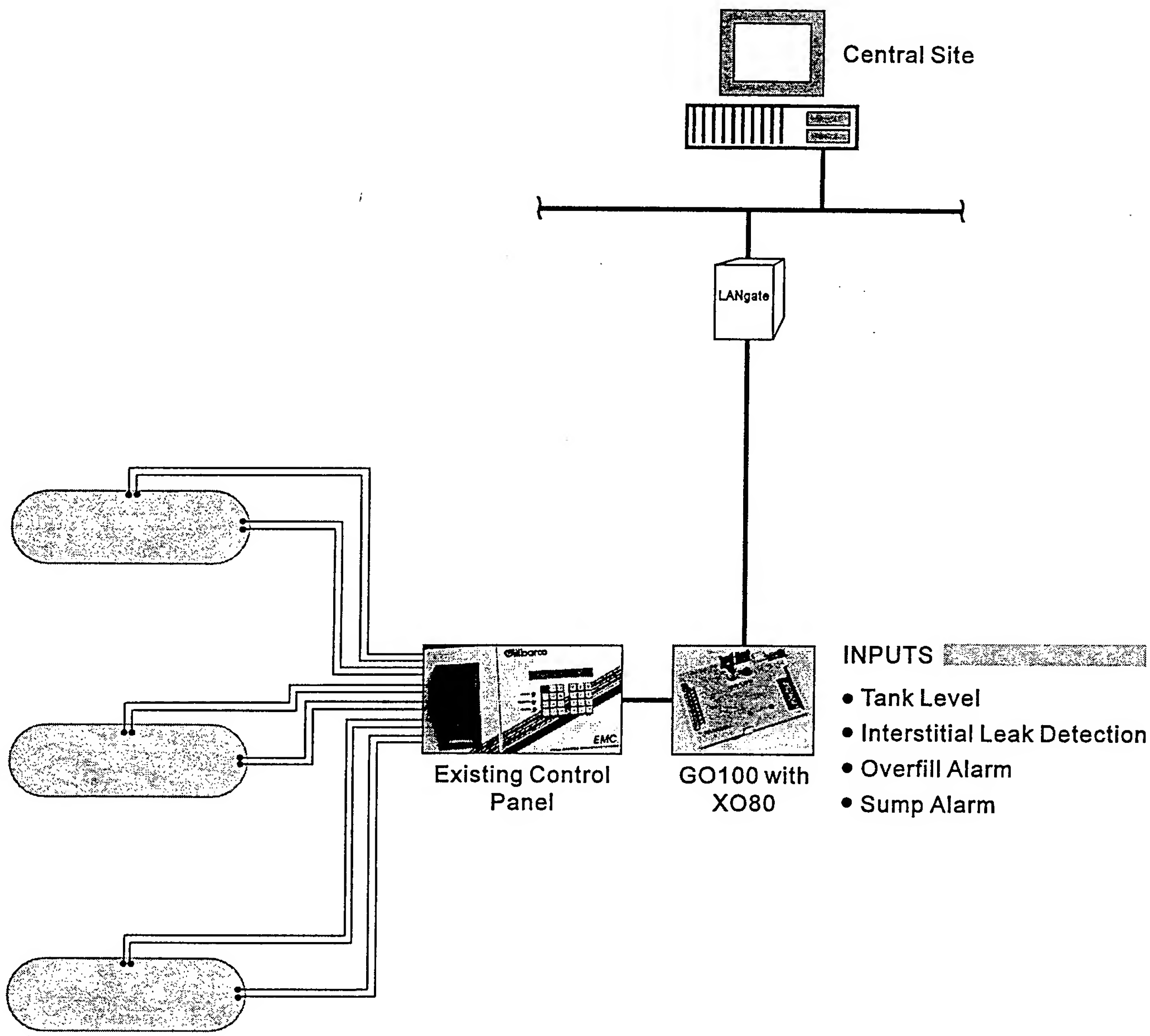


Figure 9.2.1

UNDERGROUND STORAGE TANKS MONITOR

Table 9.2.1

FORT CAMPBELL UMCS/SCADA
TANK MONITORING EQUIPMENT SCHEDULE

Module Type	Tanks	Level Indicator	Interstitial Leak Detector	Overfill Alarm	Sump Alarm
G0100	Bus Garage #1	X		X	
	Bus Garage #2	X		X	
G0100	Marshall Schools #3	X	X	X	
	Marshall Schools #4	X	X	X	
G0100 X080	92-7	X	X	X	X
	92-8	X	X	X	X
	92-9	X	X	X	X
	92-10	X	X	X	X
G0100	611-3	X		X	
	611-4	X		X	
G0100	750-2	X	X	X	
G0100	754-2	X	X	X	
G0100	1746-1	X		X	
G0100 X080	2129-1	X	X	X	X
	2129-2	X	X	X	X
	2129-3	X	X	X	X
G0100 X080	3000-1	X	X	X	X
	3000-2	X	X	X	X
	3000-3	X	X	X	X
G0100	5115-3	X	X	X	
	5113-4	X	X	X	
G0100	5660-6	X	X	X	
	5660-7	X	X	X	
	5660-8	X	X	X	
G0100	6247-1	X		X	
G0100	6327-3	X	X	X	
	6327-4	X	X	X	
G0100	6612-1	X	X	X	X
G0100	6636-1	X		X	
	6636-2	X		X	
G0100	6806-1	X		X	
G0100	6823-1	X		X	
G0100	7014-1	X		X	
G0100	7051-4	X	X	X	
	7051-5	X	X	X	
	7051-6	X	X	X	
G0100	7141A-2	X	X	X	

A life-cycle cost analysis is performed to determine the economic feasibility of connecting overfill and leak detection to the SCADA system at Fort Campbell. The LCCA is based on a ten-year life, as prescribed in the ECIP guidance. A detailed cost estimate that includes the cost of monitoring modules, control wire and conduit, and a portion of the front end cost of the SCADA system, is located in *Appendix C*. An estimated annual savings of $1,600 per year results due to the reduction in time required to check the leak detection system. It is also assumed that there will be a one time cost avoidance of $5,000 due to early detection of a leak. Existing controls are old and will need to be replaced during the ten-year period included in the life-cycle cost analysis. It is estimated that the one time cost of replacing all existing monitoring equipment is $13,700 and will occur at the mid-point of the analysis period (year five). Based on the calculations and assumptions described above, the monitoring of underground storage tanks with the SCADA system has a simple payback of 8.7 years and a savings to investment ratio of 1.0. See *Table 9.2.1.1* for the savings/costs summary for ECO 7.

Table 9.2.1.1

ECO 7 - UNDERGROUND STORAGE TANKS: COSTS/SAVINGS SUMMARY

Construction Cost (see cost estimate in Appendix C)	$27,410
Annual Energy /Savings / Costs	
Electrical Energy (MBtu/Yr)	0
Electrical Demand ($/Yr)	$0
Thermal Energy (MBtu/Yr)	
Natural Gas	0
Fuel Oil	
Non-Energy Savings / Costs Operation / Maintenance ($/Yr)	$1,600
Non-Recurring Savings / Costs Replacement Cost Clean-Up Cost Avoidance	 $13,700 $5,000

10.0 ECO 8: ATHLETIC FIELD LIGHTS

10.1 SYSTEM DESCRIPTION

An energy conservation opportunity exists at the athletic field in relation to lighting. These lights are often left on long after the athletic event is over, even through the daytime. These athletic field lights consume large amounts of wattage, over 1000 watts for each lamp.

10.2 METHOD OF APPLICATION

These lights can be centrally monitored by the SCADA system and be set to alarm for operator notification if the lights are left on beyond a set specific time. The athletic field lights will be monitored and controlled through a contactor panel and a control module which tie into the SCADA communication network. A photocell is added to ensure that lights are off during daylight hours. In addition, an adjustable timing relay, "a light request switch," is provided for timing control of lights so that the lights are only on for a specific period of time. An auxiliary circuit over rider contact will give all control back to the UMCS/SCADA operator. The athletic field lights at 18th Street and Tennessee Avenue will not require a new contactor panel. Here, the control and monitor signal can be directly picked up from the existing contactor panels. See *Figure 10.2.1*.

10.3 ECONOMIC ANALYSIS

10.3.1 Investment Costs

Investment cost estimating was performed for the monitoring and controlling of four lighted athletic fields. The common components of the communication network including head-end computer equipment, post-wide fiber optic cabling, wireless modems, software and programming were priced separately. The total cost of the common components was then divided among the systems on the network based on the number of communication nodes.

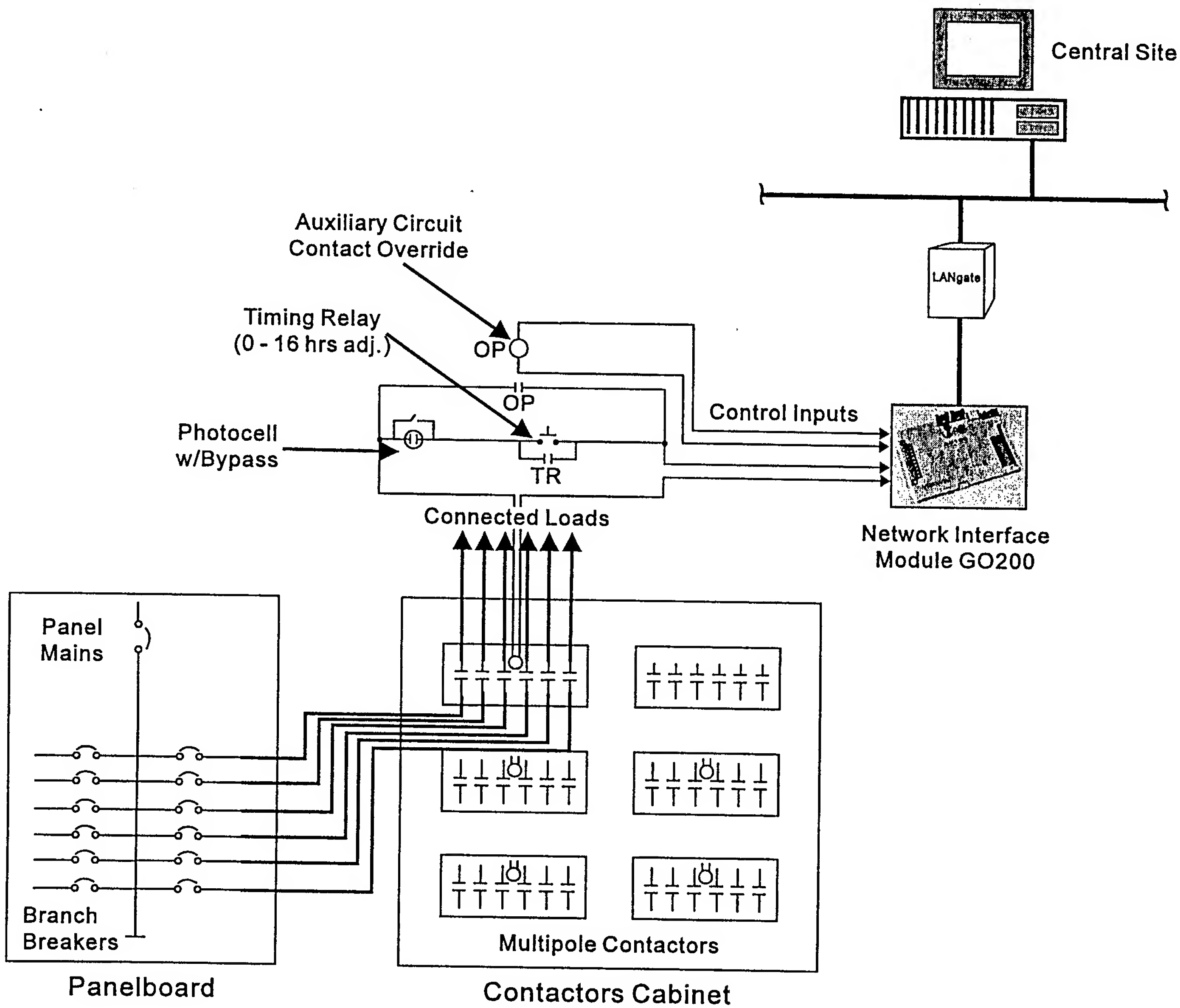


Figure 10.2.1

ATHLETIC - FIELD LIGHT MONITOR AND CONTROL

10.3.2 Energy Costs/Savings

Certain assumptions must be made on the frequency and duration of the unnecessary lighting in order to quantify energy savings benefits since no statistical data is available. The calculation method and the assumptions are listed in the following *Table 10.3.2.1.*

Table 10.3.2.1

ECO 8 - ATHLETIC FIELD LIGHTS COSTS/SAVINGS

Energy Waste Reduction

Energy Rate $/kWh: 0.02114
Demand Rate $/kW: 11.78

Energy Dollar Savings = kW x hrs x $/kWh
Demand Dollar Savings = kW x $/kW x Billing Periods

Locations	# of Fixtures	kW Saved/Fix.	Total kW Saved	Hrs/Yr Left On	Total kWh	Energy $ Saved	Demand $ Saved	Total $ Saved	MBtu Saved
18th & Tennessee	160	1.1	176	192	33,792.00	$714.36	$24,879.36	$25,593.72	115
Fryar Stadium	72	1.1	79.2	192	15,206.40	$321.46	$11,195.71	$11,517.18	52
Reed Ave	54	1.1	59.4	192	11,404.80	$241.10	$8,396.78	$8,637.88	39
39th & Indiana	52	1.1	57.2	192	10,982.40	$232.17	$8,085.79	$8,317.96	37
TOTAL	338		371.8		71,385.60	$1,509.09	$52,557.64	$54,066.74	243

Assumption: Lights are left on twice per month for 8 hours duration.

10.3.3 Maintenance Costs/Savings

No maintenance savings for this ECO.

10.3.4 Non-Recurring Costs/Savings

No non-recurring costs or savings were considered for this ECO. See Table 10.3.4.1 for the savings/costs summary for ECO 8.

Table 10.3.4.1
ECO 8 - ATHLETIC FIELD LIGHTS: COSTS/SAVINGS SUMMARY

Construction Cost (see cost estimate in Appendix C)	$47,455
Annual Energy /Savings / Costs	
Electrical Energy (MBtu/Yr)	243 MBtu/yr.
Electrical Demand ($/Yr)	$54,067/yr.
Thermal Energy (MBtu/Yr)	
Natural Gas	0
Fuel Oil	0
Non-Energy Savings / Costs Operation / Maintenance ($/Yr)0	$0
Non-Recurring Savings / Costs	$0

11.0 ECO 9: TRAFFIC SIGNAL LIGHTS

11.1 SYSTEM DESCRIPTION

Fort Campbell has fifteen intersections which have traffic signal lights. The traffic signal lights are currently being controlled by an existing microprocessor-based controller/monitor unit located at the intersection. The controllers used are Traffic Control Technologies's Series LNM and LMD. The LNM Series units are liquid crystal display indication and switch selected optional features; the LMD Series units are screen menu driven. The controller unit provides timing and logic for phase and overlap control which involves dependent movement of traffic (Green, Walk, Yellow, Red) including specific timing, position within a sequence, and set of compatibilities with other phases. The units are used to monitor for conflicting processing signal indications as well as for other specific modes of faulty operation including the absence of all signals (RED FAILURE) and the absence of proper controller voltage as set forth by the National Electrical Manufacturers Association (NEMA). The unit also monitors any existing inductive loop in the pavement or any other vehicle detector which is used to sense a vehicle's presence. The vehicle's input signal is used in conjunction with the preprogrammed timing sequence to control the volume density of the traffic. This helps to minimize the waiting period and gap between the traffic signal's phasing sequence. See *Table 11.1.1* for locations listing.

Table 11.1.1
ECO 9 - TRAFFIC SIGNAL LIGHT LOCATIONS

Location	
1) Missouri & 11th St	9) Indiana Av & 26th St
2) Missouri & 18th St	10) Indiana Av & 42nd St
3) Missouri & 26th St	11) Ohio Av & Jackson Rd
4) Missouri & 35th St	12) Ohio Av & Chaffee Rd
5) Missouri & 42nd St	13) Ohio Av & 30th St
6) Woodland Rd & Lee Rd	14) Ohio Av & Reed Av
7) Indiana Av & 18th St	15) Forrest Rd & Reed Av
8) Indiana Av & 25th St	

11.2 METHOD OF APPLICATION

In order to provide the capability to centrally monitor and control the traffic lights through a SCADA system a third party interface module will be required to communicate through the network. The monitoring and controlling functions of the traffic lights at the computer stations can then be set up through programming to mimic the local traffic signal controller. Some of the monitoring status indicators includes:

- ⇨ NORMAL OPERATION
- ⇨ CONFLICT
- ⇨ RED FAILURE
- ⇨ VOLTAGE FAILURE
- ⇨ YELLOW CLEARANCE FAILURE
- ⇨ OVERLAPPING SIGNALS FAIL
- ⇨ WATCHDOG FAILURE

On the LMD Series units, the SCADA operator will also have the capability to enter data as well as pick up all indications of the traffic lights' operating status. The controller will respond to inputs and drive outputs based on status inputs, operator programmed values, and rules of operation specified by NEMA. See *Figure 11.2.1* for system connection.

11.3 ECONOMIC ANALYSIS

11.3.1 Investment Costs

Investment cost estimating was performed for the monitoring and controlling of fifteen traffic signal lights. The common components of the communication network including head-end computer equipment, post-wide fiber optic cabling, wireless modems, software and programming were priced separately. The total cost of the common components was then divided among the systems on the network based on the number of communication nodes.

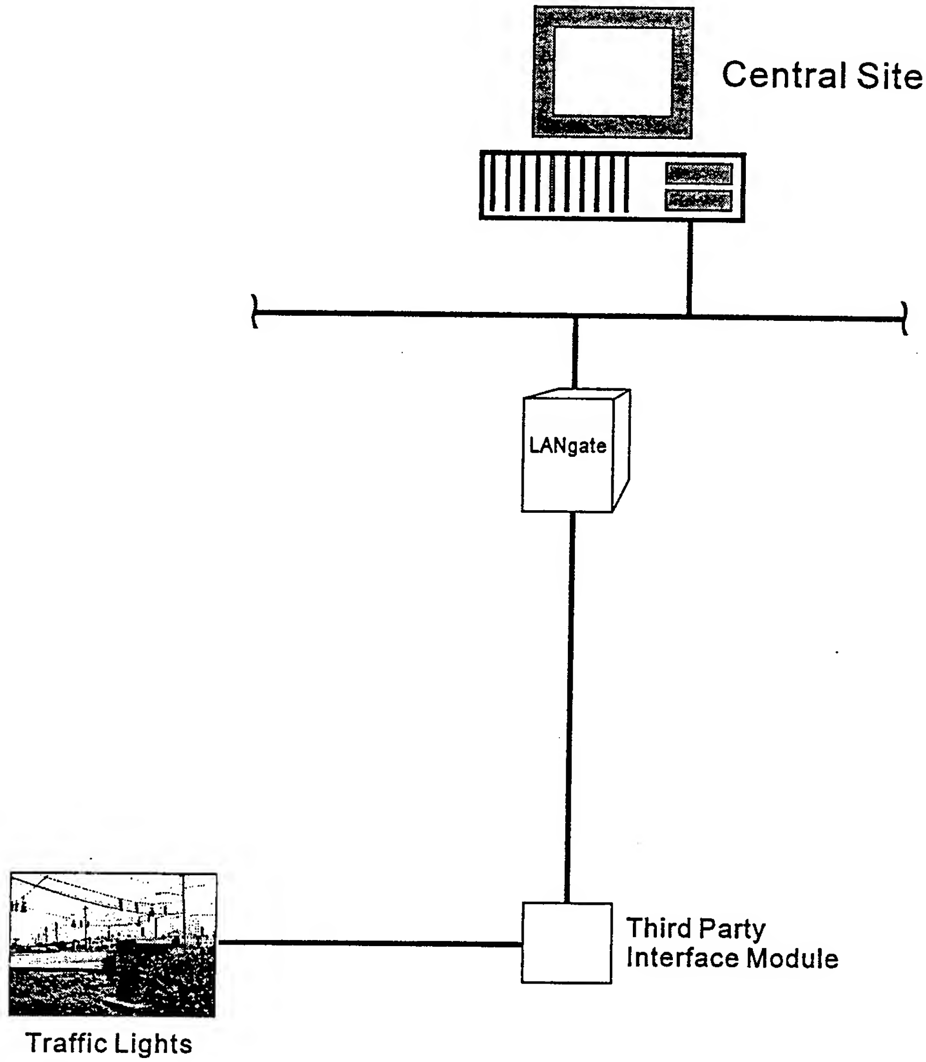


Figure 11.2.1

TRAFFIC SIGNAL MONITOR AND CONTROL

11.3.2 Energy Costs/Savings

Although there are no direct energy savings resulting from the implementation of the UMCS/SCADA system, a 75-90 percent energy reduction can be achieved with the replacement of the 100-watt red incandescent signal lamps with the new 9-25 watt multi-LED replacement units. The Light Emitting Diodes (LED) are rated for 100,000 hours of continuous operation, which is ten times longer than incandescent lamps. Therefore, for 24 hours of operation the LEDs will only have to be replaced once every ten years versus once per year for the incandescent lamps. This saves on lamp costs and the replacement labor. The LED also enhances safety because of its long life and multiple lamp assembly--it is not likely that the red light will go completely out. See the ECO 9 calculation sheet in *Appendix C.*

11.3.3 Maintenance Costs/Savings

No direct maintenance savings result from implementation of the UMCS/SCADA system. Related maintenance savings result from lamp replacement of red signal lights as described above. See the ECO 9 calculation sheet in *Appendix C.*

11.3.4 Nontangible Benefits

The benefit received from centrally monitoring and controlling of traffic signal lights come from the early detection of traffic light failures or abnormal operations such as a conflicting signal, power failure, etc. This early detection allows for corrective measures to be implemented promptly which results in minimization of traffic hazard and possibly the saving of lives. This benefit will be considered nontangible in terms of monetary value. However, the benefit is real in terms of increasing safety; therefore, it is recommended that the traffic lights be kept on the UMCS/SCADA system. See *Table 11.3.4.1* for the savings/costs summary for ECO 9.

Table 11.3.4.1
ECO 9 - TRAFFIC SIGNAL LIGHTS: COSTS/SAVINGS SUMMARY

Construction Cost (see cost estimate in Appendix C)	$140,522
Annual Energy /Savings / Costs	
Electrical Energy (MBtu/Yr)	72
Electrical Demand ($/Yr)	$339
Thermal Energy (MBtu/Yr)	
Natural Gas	0
Fuel Oil	0
Non-Energy Savings / Costs Operation / Maintenance ($/Yr)	$984
Non-Recurring Savings / Costs	$0

12.0 ECIP Project Documentation

This section contains the Project Development Brochures and the DD Form 1391 for this project.

facility

UTILITY MONITORING AND CONTROL SYSTEMS
AT FORT CAMPBELL ARMY AIRFIELD

Fort Campbell, Kentucky

project coordinator for using service

Arlin Wright

functional requirements summary, PDB-1 | 12-2

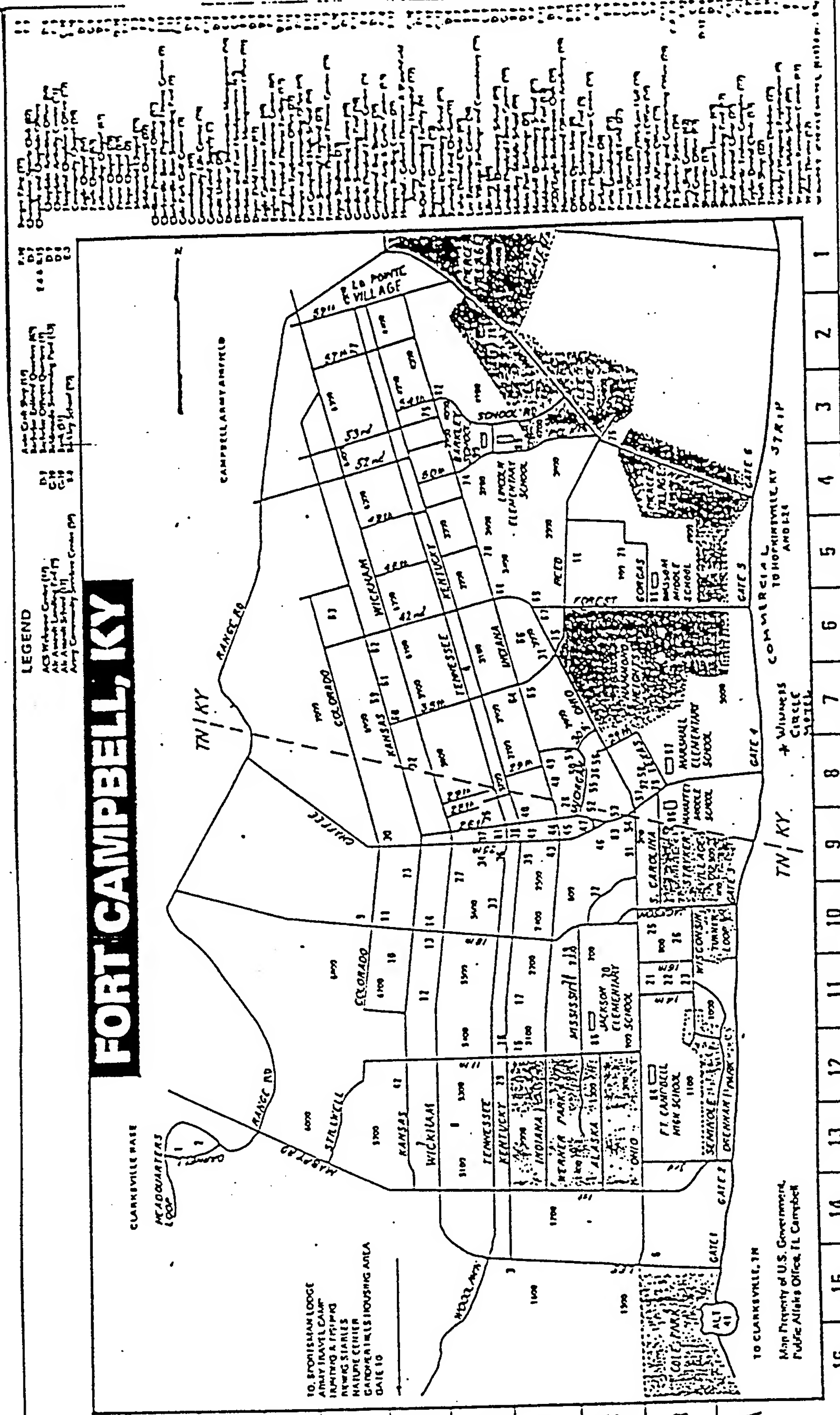
DA FORM 5020-1-R, Feb 82

OBJECTIVE:

The objective of this project is to reduce the energy consumption and cost at Fort Campbell and to comply with the Army Energy Resources Management Plan (ERMP) and Executive Order 12759 by installing utility monitoring and control system (UMCS) on Fort Campbell's facility and utility systems.

functional requirements summary, PDB-1 | 12-3

DA FORM 5020-2-R, Feb 82



facilities requirements sketch, PDB- ½

12-4

APPENDIX C
DOCUMENTATION CHECKLIST

A. SPECIAL CONSIDERATIONS

	ITEM	Required or Not Required	To Be Determined *	Comment Attached	Document Attached
A-1	Cost estimates for each primary and supporting facility	R	D		
A-2	Telecommunications system coordination with USACC and authorization for exceptions	NR			
A-3	Coordination with state and local governmental requirements (blind vendors, medical facilities, construction and operating permits, clearinghouse ccoordination, etc.)	R	A		
A-4	Assignment of airspace	NR			
A-5	Economic analysis of alternatives	R	D		
A-6	Approval for new starts	NR			
A-7	International balance of payments (IBOP) coordination with U.S. European command and NATO—overseas cost estimates and comparables (include rate of exchange used in estimates)	NR			
A-8	Impact on historic places—on site survey by authorized archeologist and coordination with state historic preservation officer and advisory council on historic preservation	NR			
A-9	Exceptions to established criteria	NR			
A-10	Coordination with various staff agencies (Provost Marshall-physical security, etc.)	R			
A-11	Identification of related or support projects (so projects can be coordinated)	R			
A-12	Required completion date	R			
	Other Special Considerations (List and number items)				

REQUIRED OR NOT REQUIRED — Not relevant or no information to communicate. Enter "R" if item is relevant and is required for this project. Enter "NR" if item is irrelevant and is not required for this project.

TO BE DETERMINED — Information needed but not currently available. Enter code for information source.

COMMENT ATTACHED — Significant information summarized or explained and attached.

DOCUMENT ATTACHED — Significant information is in an existing document which is attached.

* BY WHOM (Check and insert appropriate letter)

A — DFAE

B — Using Service

C — Construction Service

D — Designer

E — Other (Check Comments Attached and explain)

documentation checklist 12-6

DA FORM 5023-A-R, Feb 82

B. SITE DEVELOPMENT

	ITEM	Required or Not Required	To Be Determined *	Comment Attached	Document Attached
B-1	Consultation with the District Office to determine and evaluate flood plain hazards	NR			
B-2	Preparation, submission, and/or approval of new				
(A)	General Site Plan	R	D		
(B)	Annotated General Site Plan	R	D		
(C)	Sketch Site Plan	NR			
(D)	Facilities Requirements Sketch	R	D		
B-3	Preparation of				
(A)	Site Survey	R	D, C		
(B)	Subsoil information	NR			
B-4	Approval by Department of Defense Explosive Safety Board (DDESB) for Safety Site Plan	NR			
	Other Site Development Considerations (List and number items)				

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documentation checklist

12-7

DA FORM 5023-B-R, Feb 82

C. ARCHITECTURAL & STRUCTURAL

	ITEM	Required or Not Required	To Be Determined *	Comment Attached	Document Attached
C-1	Reconciliation with troop housing programs and requirements	NR			
C-2	Evaluation of existing facilities (including degree of utilization)	R	D		
C-3	Approval for removal and relocation of existing useable facilities	NR			
C-4	Evaluation of off-post community facilities	NR			
C-5	Storage and maintenance facilities (including nuclear weapons)	NR			
C-6	Coordination hospitals, medical and dental facilities with Surgeon General	NR			
C-7	Coordination of aviation facilities with FAA	NR			
C-8	Coordination air traffic control and navigational aids with USACC	NR			
C-9	Tabulation of types and numbers of aircraft	NR			
C-10	Evaluation of laboratory, research and development, and technical maintenance facilities	NR			
C-11	Coordination chapels with Chief of Chaplains	NR			
C-12	Review food service facilities by USATSA	NR			
C-13	Automated data processing system or equipment approvals—cost analysis when ADP and/or communication centers not co-located with related facilities	NR			
C-14	Coordination postal facilities with U.S. Postal Service Regional Director	NR			
C-15	Laundry and dry cleaning facilities coordination with ASD(I&L)	NR			
C-16	Tenant facilities coordination with installation where sited	NR			
C-17	Facilities for or exposed to explosions, toxic chemicals, or ammunition—review by DDESB (See also Item B-4)	NR			
C-18	Analysis of deficiencies	R	D		1
C-19	Consideration of alternatives	R	D		
C-20	Determination whether occupants will include physically handicapped or disabled persons	NR			
C-21	As-build drawings for alterations or additions	R	C		
C-22	Availability of Standard Design or site adaptable designs	NR			
	Other Architectural & Structural (List and number items)				

REQUIRED OR NOT REQUIRED — Not relevant or no information to communicate. Enter "R" if item is relevant and is required for this project. Enter "NR" if item is irrelevant and is not required for this project.

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E — Other (Check Comments Attached and explain)

documentation checklist 12-8

DA FORM 5023-C-R, Feb 82

D. MECHANICAL, ELECTRICAL, & UTILITY SYSTEMS

	ITEM	Required or Not Required	* To Be Determined	Comment Attached	Document Attached
D-1	Fuel considerations and cost comparison analysis	R	D		
D-2	Energy requirements appraisal (ERA)	R	D		1
D-3	Conformance with DOD Energy Reduction requirements	R	D		
D-4	Evaluation of existing and/or proposed utility systems	R	D		
	Other Mechanical and Utility Systems (List and number items)				

REQUIRED OR NOT REQUIRED – Not relevant or no information to communicate. Enter "R" if item is relevant and is required for this project. Enter "NR" if item is irrelevant and is not required for this project.

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E – Other (Check Comments Attached and explain)

documentation checklist 12-9

DA FORM 5023-D-R, Feb 82

E. ENVIRONMENTAL CONSIDERATIONS

	ITEM	Required or Not Required	To Be Determined *	Comment Attached	Document Attached
E-1	Environmental Impact assessment	R	D		1
E-2	EIA conclusions require Environmental Impact Statement	NR			
E-3	Determination of health, environmental or related hazards. Assistance to determine existence of any health, environmental or related hazard may be requested from Aberdeen Proving Ground, MD 21010, the Office of the Surgeon General, Attn: DASG-HCH (Army Environmental Hygiene Agency)	NR			
E-4	Air/water pollution permit, coordination with agencies and compliance with standards at Federal, state and local level	NR			
E-5	Corrective measures associated with Environmental Impact Statements or assessment—list separately and evaluate.	NR			
	Other environmental considerations (list and number items) 1. See Supplemental Data Detailed Project Justification Paragraph D9				

REQUIRED OR NOT REQUIRED — Not relevant or no information to communicate. Enter "R" if item is relevant and is required for this project. Enter "NR" if item is irrelevant and is not required for this project.

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documentation checklist

12-10

DA FORM 5023-E-R, Feb 82

APPENDIX D
TECHNICAL DATA CHECKLIST

A. SPECIAL CONSIDERATIONS

	ITEM	Required or Not Required	To Be Determined *	Comment Attached	Document Attached
A-1	Factors of risk, restriction or unusual circumstance expected to increase costs beyond applicable area averages				
A-2	Construction phasing requirements	R	D		
A-3	Functional support equipment (mechanical, electrical, structural, and security) to be built in	R	D		
A-4	Equipment in place and justification	R	D		
A-5	Other equipment and furniture (O&MA, OPA) and costs	NR			
A-6	Special studies and tests (hazards analyses, compatibility testing, new technology testing, etc.)	NR			
A-7	Type of construction (permanent, temporary, semi-permanent)	NR			
A-8	Government furnished equipment (quantities, procurement time, availability and special handling and storage requirements). Funds used for procurement.	NR			
		NR			
	Other special considerations (list and number items)				

REQUIRED OR NOT REQUIRED — Not relevant or no information to communicate. Enter "R" if item is relevant and is required for this project. Enter "NR" if item is irrelevant and is not required for this project.

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E — Other (Check Comments Attached and explain)

technical data checklist

12-12

DA FORM 5024-A-R, Feb 82

B. SITE DEVELOPMENT

	ITEM	Required or Not Required	To Be Determined*	Comment Attached	Document Attached
B-1	Construction restrictions or guidelines pertaining to				
(A)	site access and preferred construction routes	R	A		
(B)	Airfield clearance, explosive storage, working hours, safety, etc.	R	A		
(C)	Facilities and/or functions or adjoining areas (structures, materials, impact)	R	A		
B-2	Real estate actions (acquisition, disposal, lease, right-of-way)	NR			
B-3	Demolition/relocation required (data)				
(A)	Special considerations due to explosives/radioactivity/ chemical contamination/asbestos emissions/toxic gases	NR			
(B)	Restrictions on disposal of demolished/relocated material including hazardous waste	NR			
B-4	Pavement types and requirements (including traffic surveys and MTMC coordination)	NR			
B-5	Landscape considerations				
(A)	Protection of existing vegetation	R	A		
(B)	Stockpile topsoil	NR			
	Other Site Development (List and number items)				

REQUIRED OR NOT REQUIRED — Not relevant or no information to communicate. Enter "R" if item is relevant and is required for this project. Enter "NR" if item is irrelevant and is not required for this project.

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E — Other (Check Comments Attached and explain)

technical data checklist 12-13

DA FORM 5024-B-R, Feb 82

C. ARCHITECTURAL & STRUCTURAL

	ITEM	Required or Not Required	To Be Determined *	Comment Attached	Document Attached
C-1	Vibration-producing equipment requiring isolation	NR			
C-2	Seismic zone and other design load criteria (typhoon, hurricane, earthquake loads, high or low loss potential)	NR			
C-3	Protective shelter evaluation and resistant design criteria (conventional/nuclear blast and radiation, chemical/biological)	NR			
C-4	Unusual foundation requirements (pier, pile, caisson, deep foundations, mat, special treatment, permafrost areas, soil bearing)	NR			
C-5	Designation and strength of units to be accommodated	NR			
C-6	Requirements and data for special design projects	NR			
C-7	Unusual floor and roof loads (safes, equipment)	NR			
C-8	Security features (arms rooms, vaults, interior secure areas)	NR			
	Other Architectural & Structural (List and number items)				

REQUIRED OR NOT REQUIRED – Not relevant or no information to communicate. Enter "R" if item is relevant and is required for this project. Enter "NR" if item is irrelevant and is not required for this project.

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D – Designer
E – Other (Check Comments Attached and explain)

technical data checklist 12-14

DA FORM 5024-C-R, Feb 82

D. MECHANICAL, ELECTRICAL, & UTILITY SYSTEMS

	ITEM	Required or Not Required	* To Be Determined	Comment Attached	Document Attached
D-1	Special mechanical requirements or considerations (elevator, crane, hoist, etc.)	NR			
D-2	Special peak usage periods and peak leveling techniques	R	D		
D-3	Maintenance considerations (accessibility of equipment, compatibility with existing equipment)	R	D		
D-4	Plumbing—availability, general system type and characteristics (proposed and/or existing, incl. compressed air and gas)	R	D		
D-5	Heating—availability, general system type and characteristics (proposed and/or existing)	R	D		
D-6	Ventilating, air condition/refrigeration—availability, general system type and characteristics (proposed and/or existing)	R	D		
D-7	Electrical—availability, general system type and characteristics incl. airfield lighting, communication, etc. (proposed and/or existing)	R	D		
D-8	Water supply/waste treatment—availability, general system type and characteristics (proposed and/or existing)	R	D		
D-9	Energy requirements/fuel conversion (sources, availability, loads, types of fuel, etc.)	R	D		
D-10	Solar energy evaluation	NR			
	Other Mechanical & Utility Systems (List and number items)				

REQUIRED OR NOT REQUIRED — Not relevant or no information to communicate. Enter "R" if item is relevant and is required for this project. Enter "NR" if item is irrelevant and is not required for this project.

TO BE DETERMINED — Information needed but not currently available. Enter code for information source.

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A — DFAE
B — Using Service
C — Construction Service
D — Designer
E — Other (Check Comments Attached and explain)

technical data checklist

12-15

DA FORM 5024-D-R, Feb 82

E. ENVIRONMENTAL CONSIDERATIONS

	ITEM	Required or Not Required	* To Be Determined	Comment Attached	Document Attached
E-1	Waste water treatment, air quality, and solid waste disposal criteria	R	D		
	Other Environmental Considerations (List and number items)				

REQUIRED OR NOT REQUIRED — Not relevant or no information to communicate. Enter "R" if item is relevant and is required for this project. Enter "NR" if item is irrelevant and is not required for this project.

TO BE DETERMINED — Information needed but not currently available. Enter code for information source.

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*BY WHOM (Check and insert appropriate letter)

A — DFAE
B — Using Service
C — Construction Service
D — Designer
E — Other (Check Comments Attached and explain)

technical data checklist 12-16

DA FORM 5024-E-R, Feb 82

F. FIRE PROTECTION

	ITEM	Required or Not Required	To Be Determined *	Comment Attached	Document Attached
F-1	Special fire protection systems or features (detection and suppression equipment, hazards, etc.)	NR			
	Other Fire Protection Considerations (List and number items)				

REQUIRED OR NOT REQUIRED — Not relevant or no information to communicate. Enter "R" if item is relevant and is required for this project. Enter "NR" if item is irrelevant and is not required for this project.

TO BE DETERMINED — Information needed but not currently available. Enter code for information source.

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*BY WHOM (Check and insert appropriate letter)

A — DFAE
B — Using Service
C — Construction Service
D — Designer
E — Other (Check Comments Attached and explain)

technical data checklist

12-17

DA FORM 5024-F-R, Feb 82

1. COMPONENT	BY: SYSTEMS CORP	2. DATE
ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	19 January 96

3. INSTALLATION AND LOCATION	4. PROJECT TITLE
FORT CAMPBELL, KENTUCKY	UMCS/SCADA SYSTEM INSTALLATION

5. PROGRAM ELEMENT	6. CATEGORY CODE	7. PROJECT NUMBER	8. PROJECT COST ($000)
	80000	ECIP #1	$4,928.00

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
Primary Facility				
UMCS/SCADA System	Lot	1	$4,266	$4,266
Subtotal				$8,266
Contingency (10%)				$427
Total Contract Cost				$4,693
Supervision, Inspection, and Overhead (5.0%)				$235
Total Request				$4,928

10. DESCRIPTION OF PROPOSED CONSTRUCTION

The proposed project will install a state-of-the-art Utility Monitoring and Control System (UMCS) on the facility and utility systems including HVAC systems (144 buildings), electrical substations (8), remote metering (64), emergency generators (45), water system, sewage treatment system, underground storage tanks (37), athletic field lights (5), and traffic lights (15) at Fort Campbell. Implementation of this project will save 77,686 MBtu of electricity and natural gas.

11. REQUIREMENT

Project: The UMCS system will be used to effect energy and maintenance savings through the implementation of post-wide control of HVAC equipment for more efficient operation; attain energy and operational savings through effective management of the installation's water and wastewater systems; and provide monitoring and control capabilities for the installation's electrical distribution system, underground storage tanks, traffic signals, athletic field lighting systems, emergency generators, and utility metering. The first year savings is $1,348,383 and the Savings to Investment Ratio (SIR) is 2.4. Simple payback period equals 3.65 years.

Requirement: The project is required to reduce the energy consumption of Fort Campbell and to comply with the Army Energy Resources Management Plan (ERMP) and Executive Order 12759. The proposed project will reduce annual energy consumption by 77,686 MBtu/yr and annual energy cost by $841,510.

Current Situation: Currently, Fort Campbell does not have an Integrated Utility Monitoring and Control System. Due to high cost and lack of available parts, the existing Energy Monitoring and Control System is antiquated and not cost effective to operate and maintain.

1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 19 January 96
3. INSTALLATION AND LOCATION FORT CAMPBELL, KENTUCKY		
4. PROJECT TITLE UMCS/SCADA SYSTEM INSTALLATION		5. PROJECT NUMBER ECIP #1

Impact if not provided: If the proposed project is not funded, a reduction of 77,686 MBtu/yr cannot be achieved, and excessive amounts of energy will continue to be used. There will be no contribution to energy reduction goals established for United States Army facilities by Army Headquarters.

Colonel, USA
Commanding

ESTIMATED CONSTRUCTION START:	October 1996	INDEX:
ESTIMATED MIDPOINT OF CONSTRUCTION:	October 1997	INDEX:
ESTIMATED CONSTRUCTION COMPLETION:	October 1998	INDEX:

DETAILED JUSTIFICATIONS

D1. GENERAL:

The proposed project will install a state-of-the-art Utility Monitoring and Control System (UMCS) on the facility and utility systems including HVAC systems (144 buildings), electrical substations (8), remote metering (64), emergency generators (45), water system, sewage treatment system, underground storage tanks (37), athletic field lights (5), and traffic lights (15) at Fort Campbell. Implementation of this project will save 77,686 MBtu of electricity and natural gas.

D2. ACCOMMODATIONS NOW IN USE:

The existing UMCS is obsolete and ineffective as an energy management tool.

D3. ANALYSIS OF DEFICIENCY:

The current UMCS system was installed in the early 1980's and is obsolete. It is connected to approximately 60 buildings' HVAC systems only and is in poor condition throughout, effectively providing no energy management.

1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 19 January 96

3. INSTALLATION AND LOCATION FORT CAMPBELL, KENTUCKY	
4. PROJECT TITLE UMCS/SCADA SYSTEM INSTALLATION	5. PROJECT NUMBER ECIP #1

D4. CONSIDERATION OF ALTERNATIVES:

An alternative method of utility management and control does not exist.

D5. CRITERIA FOR PROPOSED PROJECT:

The proposed project will conform with all applicable federal and United States Army Regulations.

D6. PROGRAM FOR RELATED EQUIPMENT:

No equipment funded from appropriations other than MCA are required.

D7. DISPOSAL OF PRESENT ASSETS:

The current control systems will be disposed.

D8. SURVIVAL FACILITIES:

The proposed project is not suitable for inclusion of protective shelters.

D9. SUMMARY OF ENVIRONMENTAL CONSEQUENCES:

The proposed project has been analyzed and will not adversely impact the environment. Energy savings resulting from the project will conserve natural resources.

D10. EVALUATION OF FLOOD HAZARDS AND ENCROACHMENT ON WETLANDS:

It has been determined that these facilities are not located in a flood plain and they do not encroach on wetlands.

D11. ECONOMIC JUSTIFICATION:

The proposed project qualifies under ECIP Guidelines in AR-415-15. SIR for the project is 2.4 with a simple payback of 3.65 years.

See Economic Analysis, SRP-1.

1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 19 January 96
3. INSTALLATION AND LOCATION FORT CAMPBELL, KENTUCKY		
4. PROJECT TITLE UMCS/SCADA SYSTEM INSTALLATION		5. PROJECT NUMBER ECIP #1

D12. UTILITY AND COMMUNICATION SUPPORT:

A. No related utility support projects are programmed. Adequate utilities are available to support the project.

B. No telecommunications support is required.

D13. PROTECTION OF HISTORIC PLACES AND ARCHEOLOGICAL SITES:

The project involves the installation of equipment in and around existing buildings. Review procedures have been implemented for this project in accordance with 36 CFT 800. The review has established that there will be no effect.

D14. PROJECT DEVELOPMENT BROCHURE (PART 1):

A Project Development Brochure was prepared on January 19, 1996, and is included as part of the programming documentation.

D15. ENERGY REQUIREMENTS:

The proposed project will reduce present energy consumption by 77,686 MBtu/yr with a cost savings of $841,510 per year. See Energy Requirements Appraisal (ERA) in Special Requirements, Paragraph 3, (SRP-3)

D16. PROVISION FOR THE HANDICAPPED:

No provisions for the handicapped will be made since the scope of the project is in no way applicable to designing for the handicapped.

D17. REAL PROPERTY MAINTENANCE ACTIVITY (RPMA) ANALYSIS:

A. Physical Impact: No new structures will be added.

1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 19 January 96

3. INSTALLATION AND LOCATION

FORT CAMPBELL, KENTUCKY

4. PROJECT TITLE UMCS/SCADA SYSTEM INSTALLATION	5. PROJECT NUMBER ECIP #1

B. Operations and Maintenance (O&M) impact:

YEAR	O&M NET CHANGE ($000)
1997	-382.5
1998	-382.5
1999	-382.5

C. Backlog of Maintenance and Repair (BMAR) impact:

There will be no effect on BMAR.

D18. COMMERCIAL ACTIVITIES:

The proposed project is not a "New Start Expansion" as defined by DA Circular 235-1. The project has been reviewed in light of the requirements of commercial and industrial facilities. It has been determined that whereas the project does not affect commercial facilities, the requirements of DA Circular 235-1 does not apply.

1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 19 January 96

3. INSTALLATION AND LOCATION

FORT CAMPBELL, KENTUCKY

4. PROJECT TITLE UMCS/SCADA SYSTEM INSTALLATION	5. PROJECT NUMBER ECIP #1

Life Cycle Cost Analysis
Project Title: UMCS/SCADA System Installation
Fiscal Year: FY 1996
Analysis Date: 27 October 95
Economic Life: Ten (10) years

1. INVESTMENT

A. CONSTRUCTION COST	$4,480,018
B. SIOH	$ 224,001
C. DESIGN COST	$ 224,001
D. ENERGY CREDIT CALC	$ -0-
E. SALVAGE VALUE	$ -0-
F. TOTAL INVESTMENT	$4,928,020

2. ENERGY SAVINGS

ANALYSIS DATE, ANNUAL SAVINGS, UNIT COST, & DISCOUNTED SAVINGS

FUEL	COST $/MBtu (1)	SAVINGS MBtu/yr (2)	ANNUAL $ SAVINGS (3)	DISCOUNT FACTOR (4)	DISCOUNTED SAVINGS (5)
A. ELECT	6.19	3,298	$20,415	8.58	$175,157
B. DIST	5.62	(10,332)	($58,066)	9.62	($558,593)
C. RESID	0	0	0	10.53	$0
D. NG	4.35	84,720	$368,532	9.60	$3,537,907
E. DEMAND	0	0	$510,629	8.53	$4,355,665
F. TOTAL		77,686	$841,510		$7,510,137

3. NON-ENERGY SAVINGS

A. ANNUAL RECURRING		$382,538
(1) DISCOUNT FACTOR	8.53	
(2) DISCOUNTED SAVINGS		$3,263,049

B. NON-RECURRING SAVINGS:

ITEM	SAVINGS (+) COST(-)(1)	YEAR OF OCCURRENCE(2)	DISCOUNT FACTOR	DISCOUNTED SAVINGS (+) COST (-)(4)
a. Replacement	$1,118,355	5	0.86	$961,785
b. Avoidance	$125,000	5	0.86	$107,500
c.				
d. Total	$1,243,355			$1,069,285

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-) $4,332,335

1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 19 January 96
3. INSTALLATION AND LOCATION FORT CAMPBELL, KENTUCKY		
4. PROJECT TITLE UMCS/SCADA SYSTEM INSTALLATION		5. PROJECT NUMBER ECIP #1

SPECIAL REQUIREMENTS PARAGRAPH 1 (SRP-1) (continued):

4.	FIRST YEAR DOLLAR SAVINGS	$1,348,383
5.	SIMPLE PAYBACK PERIOD	3.65 Years
6.	TOTAL NET DISCOUNTED SAVINGS	$11,842,470
7.	SAVINGS TO INVESTMENT RATIO (SIR)	2.40
8.	ADJUSTED INTERNAL RATE OF RETURN (AIRR)	12.44%

1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 19 January 96
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SPECIAL REQUIREMENTS PARAGRAPH 3 (SRP-3):

Energy Requirements Appraisal (ERA):

1. Project Description: Install a Utility Management and Control System (UMCS) to improve operating and energy efficiency of utility systems at Fort Campbell.

2. Estimated Energy Consumption: Fort Campbell currently consumes 2,300,000 MBtu/yr of energy. The UMCS installation will reduce energy consumption by 3.4% (77,686 MBtu/yr).

3. Energy Sources: No new energy sources are required for the proposed project. The use of solar energy for this project is impractical.

4. Energy Use Impacts: The proposed project will substantially reduce the consumption of electricity and natural gas. The burden on the existing base distribution systems will be lessened.

5. Energy Conservation: The proposed project will reduce annual energy consumption by 77,686 MBtu/yr with annual energy cost savings of $841,510. The project complies with Army Resources Management Plan (ERMP) and Executive Order 12759.

6. Energy Alternatives: The proposed project represents the greatest possible reduction in energy consumption without reducing the current level of operations at Fort Campbell.

7. Energy Effects: The proposed project provides positive environmental effects. It reduces the current energy consumption by 3.4 percent, effectively reducing the consumption of non-renewable fuel sources.

8. Basis of Approval: Total energy requirements and alternative fuel sources have been considered and included in this appraisal or discarded as applicable.

APPENDIX A

SCOPE OF WORK

WW22WK-5072-6083

CESAM-EN-CM
CEORL-ED-MS

January 1993
March 8, 1995
Revised March 21, 1995

APPENDIX "A"
CONTRACT NO. DACA01-94-D-0034
DELIVERY ORDER NO. 0008

GENERAL SCOPE OF WORK

FOR A

FEASIBLITY STUDY, FY95S EEAP

UTILITY MONITORING & CONTROL SYSTEM (UMCS)/

SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) SYSTEM

FORT CAMPBELL, KENTUCKY

Performed as part of the

ENERGY ENGINEERING ANALYSIS PROGRAM (EEAP) FY95S

FORT CAMPBELL, KENTUCKY
SCOPE OF WORK
FOR A
FEASIBILITY STUDY, FY95S EEAP
EMCS/SCADA

TABLE OF CONTENTS

1. BRIEF DESCRIPTION OF WORK: The Architect-Engineer (A/E) shall:

1.1 Review for general information the available design, construction, and operation data for the existing EMCS (Energy Monitoring and Control System), and a proposed SCADA (Supervisory Control And Data Acquisition) System, including DDC (Direct Digital Controls), if any had been done.

1.2 Perform a Feasibility survey and Study of specific Buildings, utility, and their systems, or their facilities to collect all data required to verify construction features, electrical, and mechanical equipment, occupancy, and mode of operation for energy analysis and Energy Savings Opportunities (ECOs).

1.3 Evaluate the technical and economic feasiliblity for replacing or utilizing existing EMCS equipment with a new way to distribute-process monitoring and control systems (UMCS). The UMCS would use the personal-computer-based central operator stations and remote control units as appropriate in buildings currently served by the existing EMCS. Not all buildings on the EMCS have DDC (Direct Digital Controls).

1.4 Evaluate UMCS applications programs (software) for all buildings, or facilities using similar data, to determine the ECOs, and economic feasibility for connection to the new UMCS.

1.5 Provide complete programming or implementation documentation for all recommended projects detailed herein.

1.6 Prepare a comprehensive report to document all work performed, the results and all recommendations.

2. GENERAL

2.1 The existing EMCS is to be studied to evaluate replacement of the existing EMCS with a new PC-based UMCS, and to evaluate adding new buildings to the UMCS. All buildings shall be prioritized according to simple payback and need, that may be combined as one working unit, or as listed in Annex A, DETAILED SCOPE OF WORK.

2.2 The information and analysis outlined herein are considered to be minimum requirements for adequate performance of this study.

2.3 For the purposes of the SOW, an ECO is defined as the application of one or more UMCS energy conservation programs (applications software) within a particular building or facility. A project is defined as the connection of one or more buildings/facilities to the UMCS or replacement of the existing EMCS, and/or addition onto it.

2.4 The A/E shall ensure that all ECOs which will reduce the energy consumption or cost of operation of the installation have been considered and documented. The ECOs are limited to the standard applications listed in TM 5-815-2, "EMCS". A list of UMCS applications programs (software) to be used when evaluating specific buildings or facilities is included in TM 5-815-2 may not be applicable to the specific building or facility being evaluated; in such cases, a statement to the affect is all that is required.

2.5 The "Energy Conservation Investment Program (ECIP) Guidance", described in letter from AFPI-ENO, dated 20 JAN 1994 and the latest revision from CEHSC-FU establishes criteria for ECIP projects and shall be used for performing the economic analyses of all ECOs and projects. The program, Life Cycle Cost In Design (LCCID), has been developed for performing life cycle cost calculations in accordance with ECIP guidelines and is referenced in the ECIP Guidance. If any program other than LCCID is proposed for life cycle cost

analysis (LCCA), it must use the mode of calculation specified in the ECIP Guidance. The output must be in the format of the ECIP LCCA summary sheet, and it must be submitted for approval to the Contracting Officer.

2.6 Energy Conservation Opportunities (ECO) determined to be technically and economically feasible shall be developed into project/s acceptable to installation personnel. This may involve combining similar ECOs into larger packages which will qualify for ECIP, MCA, or PCIP funding, and determining in coordination with installation personnel the appropriate packaging and implementation approach for all feasible ECOs.

2.6.1 Project/s which qualify for ECIP funding shall be identified, separately listed, and prioritized by the Savings to Investment Ratio (SIR).

2.6.2 All feasible non-ECIP projects shall be ranked in order of highest to lowest SIR.

2.6.3 At some installations Energy Conservation and Management (ECAM) funding will be used instead of ECIP funding. The criteria for each program is the same. The Director of Public Works will indicate which program is used at this installation. This Scope of Work mentions only ECIP, however, ECAM is also meant.

3. PROJECT MANAGEMENT

3.1 Project Managers. The A/E shall designate a project manager to serve as a point of contact and liaison for work required under this contract. Upon award of this contract, the individual shall be immediately designated in writing. The A/Es designated project manager shall be approved by the Contracting Officer prior to commencement of work. This designated individual shall be responsible for coordination of work required under this contract. The Contracting Officer will designate a project manager to serve as the Government's point of contact and liaison for all work required under this contract.

3.2 Installation Assistance. The Commanding Officer or authorized representative at the installation will designate an individual to assist the A/E in obtaining information and establishing contacts necessary to accomplish the work required under this contract. This individual will be the installation representative.

3.3 Public Disclosures. The A/E shall make no public announcements or disclosures relative to information contained or developed in this contract, except as authorized by the Contracting Officer.

3.4 Meetings. Meetings will be scheduled whenever requested by the A/E or the Contracting Officer for the resolution of questions or problems encountered in the performance of the work. The A/Es project manager and the Governments representative shall be required to attend and participate in all meetings pertinent to the work required under this contract as directed by the Contracting Officer. These meetings, if necessary, are in addition to the presentation and review conferences.

3.5 Site Visits, Inspections, and Investigations. The A/E shall visit and inspect/investigate the site of the project as necessary and required during the preparation and accomplishment of the work.

3.6 Records

3.6.1 The A/E shall provide a record of all significant conferences, meetings, discussions, verbal directions, telephone conversations, etc., with Government representative(s) relative to this contract in which the A/E and/or

designated representative(s) thereof participated. These records shall be dated and shall identify the contract number, and modification number if applicable, participating personnel, subject discussed and conclusions reached. The A/E shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the records.

3.6.2 The A/E shall provide a record of requests for and/or receipt of Government-furnished material, data, documents, information, etc., which if not furnished in a timely manner, would significantly impair the normal progression of the work under this contract. The records shall be dated and shall identify the contract number and modification number, if applicable. The A/E shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the record of request or receipt of material.

3.7 Interviews. The A/E and the Governments' representative shall conduct entry and exit interviews with the Department of Public Works (DPW) before starting work at the installation and after completion of the field work. The Government's representative shall schedule the interviews at least one week in advance.

3.7.1 Entry. The entry interview shall describe the intended procedures for the survey and shall be conducted prior to commencing work at the facility. As a minimum, the interview shall cover the following points:

a. Schedules.

b. Names of energy analysts who will be conducting the site survey.

c. Proposed working hours.

d. Support requirements from the Department of Public Works.

3.7.2 Exit. The exit interview shall briefly describe the items surveyed and probable areas of energy conservation. The interview shall also solicit input and advice from the DPW.

4. SERVICES AND MATERIALS. All services, materials (except those specifically enumerated to be furnished by the Government), plant, labor, supervision and travel necessary to perform the work and render the data required under this contract are included in the lump sum price of the contract.

5. PROJECT DOCUMENTATION. All ECOs which the A/E has considered shall be included in one of the following categories and presented in the report as such:

5.1 ECIP Projects. To qualify as an ECIP project, an ECO, or several ECOs which have been combined, must have a construction cost estimate greater than $300,000, a Savings to Investment Ratio (SIR) greater than 1.25 and a simple payback period of less than ten years.

The overall project and each discrete part of the project shall have a SIR greater than 1.25. All projects meeting the above criteria shall be arranged as specified in paragraph 2.6.1 and shall be provided with programming documentation. Programming documentation shall consist of a DD Form 1391, Life Cycle Cost Analysis (LCCA) summary sheet(s) (with necessary backup data to verify the numbers presented), and a Project Development Brochure (PDB). A LCCA summary sheet shall be developed for each ECO and for the overall project when more than one ECO are combined. The energy savings for projects consisting of multiple ECOs must take into account the synergistic effects of the individual ECOs. For projects and ECOs reevaluated from previous studies, the backup data shall consist of copies of

the original calculations and analysis, with new pages revising the original calculations and analysis. In addition, the backup data shall include as much of the following as is available: the increment of work under which the project or ECO was developed in the previous study, title(s) of the project(s), the energy to cost (E/C) ratio, the benefit to cost (B/C) ratio, the current working estimate (CWE), and the payback period. The purpose of this information is to provide a means to prevent duplication of projects in any future reports.

5.2 Non-ECIP Projects. Projects which do not meet ECIP criteria with regard to cost estimate or payback period, but which have an SIR greater than 1.25 shall be documented. Projects or ECOs in this category shall be arranged as specified in paragraph 2.6.2 and shall be provided with the following documentation: the LCCA summary sheet completely filled out, a description of the work to be accomplished, backup data for the LCCA, ie, energy savings calculations and cost estimate(s), and the simple payback period. The energy savings for projects consisting of multiple ECOs must take into account the synergistic effects of the individual ECOs. In addition these projects shall have the necessary documentation prepared, as required by the Government's representative, for one of the following categories:

a. Federal Energy Management Program (FEMP) Projects. A FEMP (or O&M Energy) project is one that results in needed maintenance or repair to an existing facility, or replaces a failed or failing existing facility, and also results in energy savings. The criteria are similar to the criteria for ECIP projects, ie, SIR$\geq$ 1.25, and simple payback period of less than ten years. Projects with a construction cost eximate up to $1,000,000 shall be documented as outlined in par. 5.2 above; projects over $1,000,000 shall be documented on 1391s. In the FEMP program, a system may be defined as "failing or failing" if it is inefficient or technically obsolete. However, if this strategy is used to justify a proposed project, the equipment to be replaced must have been in use for at least three years.

b. Low Cost/No Cost Projects. These are projects which the Director of Public Works (DPW) can perform using his resources. Documentation shall be as required by the DPW.

5.3 Nonfeasible ECOs. All ECOs which the AE has considered but which are not feasible, shall be documented in the report with reasons and justifications showing why they were rejected.

6. DETAILED SCOPE OF WORK. The Detailed Scope of Work is contained in Annex A.

7. WORK TO BE ACCOMPLISHED.

7.1 Review Previous Studies. Review the previous EEAP study which applies to the specific building, system, or ECO covered by this study. This review should acquaint the A/E with the work that has been performed previously. Much of the information the A/E may need to develop the ECOs in this study may be contained in the previous study.

7.2 Perform Site Surveys. The A/E shall obtain all necessary data to evaluate the ECOs or project/s by conducting a site survey. However, the A/E is encouraged to use any data that may have been documented in any previous

study. The A/E shall document his site survey on forms developed for the survey, or standard forms, and submit these completed forms as part of the report. All test and/or measurement equipment shall be properly calibrated prior to its use.

7.3 Reevaluate Selected Projects. The A/E shall reevaluate the projects and ECOs listed in Annex A. These are projects and ECOs that the previous study has identified but that have not been accomplished or only parts have been accomplished. If the project or ECO is acceptable as is, that is, there are no changes to the basic project or ECO, the energy savings shown in the previous project may be accepted as accurate but the energy cost and construction cost estimates shall be updated based on the most current data available. With the above information the project shall then be analyzed based on current ECIP criteria. If the project or ECO is basically acceptable but some of the buildings in the original project have been deleted or new buildings can be added, the necessary changes shall be made to the energy savings, the energy costs and construction costs shall be updated, and the revised project or ECO shall then be analyzed using current ECIP guidance. If the original project or ECO has had numerous changes made to it so that all of the numbers are suspected of being inaccurate, but the project or ECO is still considered feasible, the A/E shall develop the project from the beginning and analyze it with the current ECIP guidance. These projects shall be separately listed in the report.

7.4 Evaluate Selected ECOs. The A/E shall analyze the ECOs listed in Annex A. These ECOs shall be analyzed in detail to determine their feasibility. SIRs shall be determined using current ECIP guidance. The A/E shall provide all data and calculations needed to support the recommended ECO. All assumptions and engineering equations shall be clearly stated. Calculations shall be prepared showing how all numbers in the ECO were figured. Calculations shall be an orderly step-by-step progression from the first assumption to the final number. Descriptions of the products, manufacturers catalog cuts, pertinent drawings and sketches shall also be included. A LCCA summary sheet shall be prepared for each ECO and included as part of the supporting data.

7.5 Combine ECOs Into Recommended Projects. During the Interim Review Conference, as outlined in paragraph 7.6.1, the A/E will be advised of the DPW's preferred packaging of recommended ECOs into projects for implementation. Some projects may be a combination of several ECOs, and others may contain only one. These projects will be evaluated and arranged as outlined in paragraphs 5.1, 5.2, and 5.3. Energy savings calculations shall take into account the synergistic effects of multiple ECOs within a project and the effects of one project upon another. The results of this effort will be reported in the Final Submittal per paragraph 7.6.2.

7.6 Submittals, Presentations and Reviews. The work accomplished shall be fully documented by a comprehensive report. The report shall have a table of contents and an index. Tabs and dividers shall clearly and distinctly divide sections, subsections, and appendices. All pages shall be numbered. Names of the persons primarily responsible for the project shall be included. The A/E shall give a formal presentation of the interim submittal to installation, command, and other Government personnel. Slides or view graphs showing the results of the study to date shall be used during the presentation. During the presentation, the personnel in attendance shall be given ample opportunity to ask questions and discuss any changes deemed necessary to the study. A review conference will be conducted the same day, following the presentation. Each comment presented at the review conference will be discussed and resolved or action items assigned. It is anticipated that the presentation and review conference will require approximately one working day. The presentation and review conference will be at the installation on the date agreeable to the DPW, the A/E and the Governments'

representative. The Contracting Officer may require a resubmittal of any document(s), if such document(s) are not approved because they are determined by the Contracting Officer to be inadequate for the intended purpose.

7.6.1 Interim Submittal. An interim (60%) report shall be submitted for review after the field survey has been completed and an analysis has been performed on all of the ECOs. The report shall indicate the work which has been accomplished to date, illustrate the methods and justifications of the approaches taken and contain a plan of the work remaining to complete the study. Calculations showing energy and dollar savings, SIR, and simple payback period of all the ECOs shall be included. The results of the ECO analyses shall be summarized by lists as follows:

a. All ECOs eliminated from consideration shall be grouped into one listing with reasons for their elimination as discussed in par. 5.3.

b. All ECOs which were analyzed shall be grouped into two listings, recommended and non-recommended, each arranged in descending order of SIR. These lists may be subdivided by building or area as appropriate for the study.

The A/E shall submit the Scope of Work and any modifications to the Scope of Work as an appendix to the report. A narrative summary describing the work and results to date shall be a part of this submittal. At the Interim Submittal and Review Conference, the Governments' and A/Es' representatives shall coordinate with the DPW to provide the A/E with direction for packaging or combining ECOs for programming purposes and also indicate the fiscal year for which the programming or implementation documentation shall be prepared. The survey forms completed during this audit shall be submitted with this report. The survey forms only may be submitted in final form with this submittal. They should be clearly marked at the time of submission that they are to be retained. They shall be bound in a standard three-ring binder which will allow repeated disassembly and reassembly of the material contained within.

7.6.2 Final Submittal. The A/E shall prepare and submit the final report when all sections of the report are 100% complete and all comments from the interim submittal have been resolved. The A/E shall submit the Scope of Work for the study and any modifications to the Scope of Work as an appendix to the submittal. The report shall contain a narrative summary of conclusions and recommendations, together with all raw and supporting data, methods used, and sources of information. The report shall integrate all aspects of the study. The recommended projects, as determined in accordance with paragraph 5, shall be presented in order of priority by SIR. The lists of ECOs specified in paragraph 7.6.1 shall also be included for continuity. The final report and all appendices shall be bound in standard three-ring binders which will allow repeated disassembly and reassembly. The final report shall be arranged to include:

a. An Executive Summary to give a brief overview of what was accomplished and the results of this study using graphs, tables and charts as much as possible (see Annex B for minimum requirements).

b. The narrative report describing the problem to be studied, the approach to be used, and the results of this study.

c. Documentation for the recommended projects (includes LCCA Summary Sheets).

d. Appendices to include as a minimum:

1) Energy cost development and backup data
2) Detailed calculations
3) Cost estimates
4) Computer printouts (where applicable)
5) Scope of Work

DATE: May 15, 1995

U.S. ARMY ENGINEER DISTRICT, LOUISVILLE

A-E Support Section

TO: Systems Corp - Keith Derrington

Office / Location: Knoxville, TN.

FAX Number: (615) 524-7514

Classification: FOUO / UUUU

Priority: ASAP / Routine

Number of Pages (incl header sheet): 20 (9 + 11)

FROM: Chuck Lockman, CEORL-ED-MS, (502) 582-6041 FAX: (502) 582-6763

SUBJECT: SOW UMCS/SCADA @ FTC

A-E Support Section FAX Number: (502) 582-6763 Confirmation Number: (502) 582-6904

Louisville District's FAX Number: (502) 582-5281 Confirmation Number: (502) 582-5962

LOUISVILLE DISTRICT CORPS OF ENGINEERS
ENGINEERING DIVISION, A/E MANAGEMENT BRANCH (CEORL-ED-MS)

ANNEX A
DETAILED SCOPE OF WORK
FORT CAMPBELL, KENTUCKY

March 8, 1995

1. PROJECT NAME & LOCATION: - FY95S EEAP, Feasibility Study (FS), UMCS/SCADA (Utility Maintenance Control System/Supervisory Control And Data Acquisition) is as follows:

A. EMCS Upgrade to UMCS- Study the feasibility and requirements for upgrading the existing EMCS to 100% DDC (Direct Digital Control) to tie into SCADA, along with FM controls to remotely start/stop standby generators, including test sites for military generators. Includes flight simulators and hangars, but not the hospital. See paragraph 5 below for more detail.

B. Electrical Energy System- Study the feasibility and requirements for a SCADA System to determine types of electrical loads on each substation (8 each), and methods of metering and control of each by AM/FM monitoring and control devices. The water plant and 60± sewage lift stations are also to be evaluated for SCADA monitoring and control operation. SCADA must interface and be included with the UMCS. See paragraph 5 below for more detail. (See page A-1b for C. Additional 5 Items determined a Pre-Neg'n meeting.)

2. GENERAL SOW vs. DETAILED SOW: The GSOW (General Scope of Work) will apply to contract efforts as modified by the Detailed SOW (DSOW). Should conflicts occur between the GSOW and the DSOW, the DSOW shall govern.

3. RESPECTIVE POC's for this study:

Louisville District COE- Charles (Chuck) Lockman/CEORL-ED-MS
Contracting Officer Representative (COR)
(502) 582-6040, fax #6763, or 5281

Fort Campbell DPW- Arlin Wright, Energy Officer DPW-MESB
(502) 798-8895, fax#7840

Architect/Engineer (A/E) - Ned W. (Chuck) Belt, President
Systems Corp., Suite 306, Cherokee Pl
2200 Sutherland Avenue
Knoxville, TN 37919
(615) 521-6536, or FAX#524-7514

4. SCOPE:

4.1 The A/E shall provide all work necessary to complete the Feasibility Study as defined by the GSOW including the Annexes. Information and instructions contained within the DSOW are provided as a means for the A/E Project Manager to expand, or modify the GSOW as may be needed to suit the study for project area listed in 1. above. This study is meant to address specific opportunities, buildings, or systems that the installation feels have high potential for energy or dollar savings.

4.2 The study will analyze a UMCS/SCADA system for energy conservation savings in buildings, utilities, and systems in use by the Using Agency. Materials, utilities, and other components of these operations, are to be investigated and determine any energy savings methods/recommendations/new technology identified. This could include interview of personnel to gather data for quantities, and operational data. Alternate energy sources could be included.

4.3 The study will consider new designs for UMCS energy trends that make these systems more cost effective, energy saving, and user friendly.

4.4 If metering of a facility is required, the A/E shall assist the DPW in arranging for the installation of electrical metering, however, existing data is available at the installation, and by other studies/ surveys.

FY95S EEAP, F.S.- UMCS/SCADA, FORT CAMPBELL,KY.

March 21, 1995- Scope of Work REVISION for additional requirements determined at pre-negotiation scoping meeting are as follows:

1. PROJECT NAME & LOCATION-ADDITION:

C. Additonal buildings/systems that needs to be added onto the UMCS:

1. UMCS electrical and gas pulse metering of reimbursable customers.

2. UMCS lighting control of all existing athletic lighted fields, monitoring and control.

3. UMCS control of Water towers for space and overfill monitoring and controls.

4. UMCS control of Traffic signals for monitoring and control.

5. UMCS control of underground storage tanks for space and overfills.

5. DETAILED REQUIREMENTS: All detail requirements selected at Fort Campbell for the purpose of this feasibility study, shall specifically include the existing EMCS systems, utilities, and buildings, as listed in paragraph 1. above and projects identified by the DPW staff.

The existing EMCS is Williams Electric, Robers-Shaw, and etc., or a third generation systems. The installation is now updating switches to replace old switches. The central control area needs to be more productive base-wide for additional usages, be user friendly, needs to capture older separated systems, be adaptable to the various brands of existing equipment used on the installation by possibly changing equipment or adapting changeover equipment, integrate systems into the central control, network at designated stations, and capability to access portable command units that would assist the central operator, and/or let the central operator have control. User needs equipment that is of one manufacture that would readily adapt new/future technology and allow additional system needs to be added at a later time.

More details are as follows:

A. EMCS Upgrade to UMCS- The new system upgrade will automatically adjust temperatures and humidity, shed electrical loads, control motor speeds, and adjust lighting intensities. The latest smart equipment and technology will be used, as well as compatible software/hardware. The new UMCS equipment furnished in the system should be expandable and not changed into a separate confused network. The contractor will review existing building, utility, and systems drawings; survey and monitor existing systems, and analyze any additional UMCS styled energy saving equipment discovered during the field survey. Link trainer equipment in hangars will read back to the UMCS all calibrations, operations, and humidity for feed back for the operation going on at those specific controls. A/E will need to visit each system in order to appropriately integrate a system from the existing systems.

B. Electrical Energy System- Connect into the (8) eight electrical distribution substations, and mechanical systems capability for control of the humidity, HVAC, switch gear, pump rates and lights by zones at various shops and buildings into a user friendly UMCS system. System controls are to be configured such that they may be operated from a central point as well as from remote/roving locations. User is concerned that old systems will not interface with new technologies to which this study will recommend and/or change out the equipment and/or interface new control equipment, that will allow a centralized control with multi-networking positions on the installation.

Several buildings have their own EMCS controls and systems that will be brought on line to the new UMCS, however, individual controls at the functional point must also be maintained, as well new networking must be considered at the PC and Multi-Station levels for the customer. Several manufactured controls have been installed at the various buildings and adapting or changing out equipment to adapt to the UMCS will be considered and recommended in this study.

6. PERFORMANCE: The total time required for completion of the study and the performance of all work shall not be more than 180 calendar days from the Notice to Proceed (NTP) on the contract. If the study takes the A/E less time than scheduled to achieve, a shortened schedule for submittal and coordination of review and interim review meeting at the installation may be coordinated by the A/E with all parties involved in the review process. Figure A-6.1 is a schedule of pertinent events and milestone dates for acceptable performance of the feasibility study at Fort Campbell. Changes or adjustments made to the SOW during the term of the feasibility study shall be made by the COE.

7. SUBMITTALS: The A/Es Project Manager shall provide direct distribution of

all required submittals and documents in the numbers as listed in Figure A-7.1.

8. GOVERNMENT-FURNISHED INFORMATION: The following list of reference documents will be furnished to the A/E:

a. ETSs 1110-3-282 Energy Conservation.
b. Energy Conservation Investment Program (ECIP) Guidance, dated 10 Jan 1994 and the latest revision with current energy prices and discount factors for life cycle cost analysis.
c. AR 415-15, Military Construction, Army (MCA) Program Development.
d. The latest MCP Index.
e. Drawings at the DPW of each facility.
f. EMCS Guide Specifications:
1. CEGS 13810- Energy Monitoring and Control System (EMCS) Large Configuration.
2. CEGS 13814- Building Preparation for Monitoring and Control Systems.
3. CEGS 13945- Multi-Building Expansion of Energy Monitoring and Control Systems.
4. CEGS 16795- Fiber Optics Data Transmission System.
5. CEGS 16935-
g. Site Survey Procedures for EMCS, if applicable, HNDSP86-188-ED-ME.
h. User Guide for single building controllers UG-0010.
i. EMCS Cost Estimating Guidelines, HNDSP90-244-ED-ME.
j. Previous studies related to application of EMCS at this site, where applicable.
k. Energy Monitoring & Control Systems Technical Manual, TM 5-815-2.
l. ER 1110-3-109, Corps-Wide Centers of Expertise Assigned to Major subordinate Commands and Districts, 15 July 1992.

9. LCCID FROM BLAST: A computer program, dated October 1994, titled Life Cycle Costing in Design (LCCID) will be used from the BLAST Support Office in Urbana, Illinois. It will be used for performing the economic calculations for ECIP and non-ECIP ECOs. The Louisville District can support the A/E with a copy of that program, or it can be purchased directly from the Blast Support Office.

10. Simulation Programs acceptable for use in this study are listed below. Any substitutes must be submitted and approved as outline in the basic SOW.

a. Building Loads and System Thermodynamics (BLAST)

b. DOE 2.1B

c. Carrier E20 or Hourly Analysis Program (HAP)

d. Trane Air-Conditioning Economics (TRACE)

e. Beacon

FIGURE A-6.1.

May 09, 1995

SCHEDULE FOR FY95S EEAP, FEASIBILITY STUDY,
UMCS/SCADA
FORT CAMPBELL, KY

MILESTONE	DATE
TCX to FOA w/ltr. to proceed w/scoping..........	November 18, 1994
Initial FOA to POC at the DPW....................	December 20, 1994
FOA prepares Pre-DSOW w/o DPW....................	January 11, 1995
PreDSOW from FOA to DPW for 1st review..........	January 23, 1995
Auth./Scheduling letter 6 Jan received @FOA......	January 26, 1995
EEAP Schedule to CEMP-ET........................	S:February 10, 1995
PreDSOW informal FOA Scope Mtg. @FK by FOA & DPW. w/MACOM, CERL, and Ballelle Lab.	February 14, 1995
SOW sent by FOA to DPW, MACOM, MCX prior to SOW meeting at FC..................	March 09, 1995
FOA revises SOW & readied for RFP...............	March 09, 1995
Request For Proposal w/scope to A/E.............	March 15, 1995
Pre-Neg'n SOW Meeting/Site Visit @FC, w/ FOA, MCX, DPW, MACOM, A/E............................	March 21, 1995
SOW Revision	March 21, 1995
RFP from A/E to FOA for Neg'ns..................	April 10, 1995
Negotiations started at FOA.....................	April 13, 1995
Negotiations Completed by FOA & Request to TCX for Funding..................................	April 13, 1995
Funds furnished FOA from TCX for contract........	April 28, 1995
Awardable of Contract for FC Energy Project......	(May 03, 1995)
Start Up Field Work Award...................... (Entry Interview, A/E had to schedule personnel w/o award)	day 1/award (May 22,23, 1995)
Interim 60% Submittal of FC.....................	90 days/award (August 26, 1995)
Interim 60% Review Meeting at FC................ (Exit Interview)	110 days/award (September 15, 1995)
Final Report w/1391 data........................	180 days/award (November 23, 1995)

FIGURE A-7.1. Distribution of Submittals: The A/E shall make direct submittal and responses to comments as indicated by the following schedule:

Organization	Correspondence	Executive Summary	Reports	Fieldnotes
COMMANDER, US Army Engineer District, Louisville ATTN: CEORL-ED-Ms/Charles Lockman P.O. Box 59 (express-600 Dr.Martin King Place) Louisville, KY 40201-0059 tel. (502) 582-6041, or fax# 6763, or 5281	1	3	3***	3*
HQ 101 Abn Div (AASLT) & Ft.Campbell ATTN: AFZB-DPW-MESB/Arlin E. Wright 16th & Ohio St., Bldg. T-865 (DPW) Fort Campbell, KY 42223-1291 tel. (502) 798-8895, or fax# 7840	1	3	3***	3*
Headquarters FORSCOM (MACOM) ATTN: FCEN-RDF/R.B. Maynor Energy Office, Building 200 Fort McPherson, GA 30330-6000 tel. (404) 669-6299, or fax# 7751	1	1	1	1*
COMMANDER, US Army Engineer District, Mobile ATTN: CESAM-EN-CC/Tony Battaglia (EEAP TCX) P.O. Box 2288 (express-109 St.Joseph Street) Mobile, AL 36628-0001 tel. 205-690-2618, or fax# 2424	1	1**	1	0
COMMANDER, US Army Engineer Div., Ohio River ATTN: CEORD-DL-M/Joe Semrad P.O. Box 1159 Cincinnati, OH 45201-1159 tel. 513-684-3975	0	1**	0	0
COMMANDER, US Army Corps of Engineers ATTN: CEMP-ET/Dan Gentil (EEAP Mgr.) 20 Massachusetts Avenue Washington, D.C. 20314-1000 tel. 202-272-0430	0	1**	0	0
COMMANDER, US Army Logistics Evaluation Agency ATTN: LOEA-PL/Mr. Keath New Cumberland Army Depot New Cumberland, Pa. 17070-5006	0	1**	0	0
COMMANDER, US Army Division, Huntsville ATTN: CEHND-ED-ME-T/Mr. Chuck Holland (UMCS-MCX) P.O. Box 1600 Huntsville, AL 35805-1957 tel. 205-895-1741, fax#205-895-1519	1	2***	2	2*
Battelle, Pacific Northwest Laboratories ATTN: Dick Meador, Senior Research Engineer P.O. Box 999 (Express-Battelle Boulevard) Richland, WA 99352 tel. 509-372-4098	0	1**	1	1*

(Distribution of Submittals-continued next page)

U.S. Army CERL, CECER-FEP ATTN:Rick Runkus,Principal Investigator P.O. Box 9005 Champaign, IL 61826-9005 tel. 217-373-3432	0	1**1	1*
HQ 101 Abn Div (AASLT) & Ft. Campbell ATTN:Karen Kopp, Utilities Branch Chief 868 16th Street & Chio Avenue Fort Campbell, KY 42223-5130 tel. 502-798-5082	0	1**1	1*
HQ 101 Abn Div (AASLT) & Ft. Campbell ATTN:William D. Henson, EMCS Controls 16th & Ohio Streets, Bldg. 865 Fort Campbell, KY 42223-5130 tel. 502-798-3913	0	1**1	1*

* Field Notes submitted in final at Interim submittal.
** Submit copies of the final Executive Summary Only
***Computer printout along w/report.

FC

ANNEX B

EXECUTIVE SUMMARY GUIDELINE

1. Introduction.

2. Building Data (types, number of similar buildings, sizes, etc.)

3. Present Energy Consumption of Buildings or Systems Studied.

   o Total Annual Energy Used.

   o Source Energy Consumption.
   Electricity - KWH, Dollars, BTU
   Fuel Oil - GALS, Dollars, BTU
   Natural Gas - THERMS, Dollars, BTU
   Propane - GALS, Dollars, BTU
   Other - QTY, Dollars, BTU

4. Reevaluated Projects Results.

5. Energy Conservation Analysis.

   o ECOs Investigated.

   o ECOs Recommended.

   o ECOs Rejected. (Provide economics or reasons)

   o ECIP Projects Developed. (Provide list)*

   o Non-ECIP Projects Developed. (Provide list)*

   o Operational or Policy Change Recommendations.

* Include the following data from the life cycle cost analysis summary sheet: the cost (construction plus SIOH), the annual energy savings (type and amount), the annual dollar savings, the SIR, the simple payback period and the analysis date.

6. Energy and Cost Savings.

   o Total Potential Energy and Cost Savings.

   o Percentage of Energy Conserved.

   o Energy Use and Cost Before and After the Energy Conservation Opportunities are Implemented.

ANNEX C

REQUIRED DD FORM 1391 DATA

To facilitate ECIP project approval, the following supplemental data shall be provided:

a. In title block clearly identify projects as "ECIP."

b. Complete description of each item of work to be accomplished including quantity, square footage, etc.

c. A comprehensive list of buildings, zones, or areas including building numbers, square foot floor area, designated temporary or permanent, and usage (administration, patient treatment, etc.).

d. List references, and assumptions, and provide calculations to support dollar and energy savings, and indicate any added costs.

(1) If a specific building, zone, or area is used for sample calculations, identify building, zone or area, category, orientation, square footage, floor area, window and wall area for each exposure.

(2) Identify weather data source.

(3) Identify infiltration assumptions before and after improvements.

(4) Include source of expertise and demonstrate savings claimed. Identify any special or critical environmental conditions such as pressure relationships, exhaust or outside air quantities, temperatures, humidity, etc.

e. Claims for boiler efficiency improvements must identify data to support present properly adjusted boiler operation and future expected efficiency. If full replacement of boilers is indicated, explain rejection of alternatives such as replace burners, nonfunctioning controls, etc. Assessment of the complete existing installation is required to make accurate determinations of required retrofit actions.

f. Lighting retrofit projects must identify number and type of fixtures, and wattage of each fixture being deleted and installed. New lighting shall be only of the level to meet current criteria. Lamp changes in existing fixtures is not considered an ECIP type project.

g. An ECIP life cycle cost analysis summary sheet as shown in the ECIP Guidance shall be provided for the complete project and for each discrete part included in the project. The SIR is applicable to all segments of the project. Supporting documentation consisting of basic engineering and economic calculations showing how savings were determined shall be included.

h. The DD Form 1391 face sheet shall include, for the complete project, the annual dollar and MBTU savings, SIR, simple amortization period and a statement attesting that all buildings and retrofit actions will be in active use throughout the amortization period.

i. The calendar year in which the cost was calculated shall be clearly shown on the DD Form 1391.

j. For each temporary building included in a project, separate documentation is required showing (1) a minimum 10-year continuing need, based on the installation's annual real property utilization survey, for active

building retention after Retrofit, (2) the specific retrofit action applicable and (3) an economic analysis supporting the specific retrofit.

k. Nonappropriated funded facilities will not be included in an ECIP project without an accompanying statement certifying that utility costs are not reimbursable.

l. Any requirements required by ECIP guidance dated 4 Nov 1992 and any revisions thereto. Note that unescalated costs/savings are to be used in the economic analyses.

m. The five digit category number for all ECIP projects except for Family Housing is 80000. The category code number for Family Housing projects is 71100.

GLOSSARY OF ACRONYMS

A/E	Architect Engineer
AR	Army Regulation
B/C	Benefit to Cost
COE	Corps of Engineers
CWE	Current Working Estimate
DDC	Direct Digital Control
DPW	Director of Public Works
DOD	Department of Defense
DSOW	Detailed Scope of Work
E/C	Energy to Cost
ECAM	Energy Conservation and Management
ECIP	Energy Conservation Investment Program
ECO	Energy Conservation Opportunity
EEAP	Energy Engineering Analysis Program
EHSC	Engineering and Housing Support
EMCS	Energy Monitoring Control System
ESOS	Energy Savings Opportunity Survey
GSOW	General Scope of Work
HQUSACE	Headquarters US Army Corps of Engineers
LCCA	Life Cycle Cost Analysis
LCCID	Life Cycle Cost In Design
MACOM	Major Army Command
MCA	Military Construction Army
NECPA	National Energy Conservation Policy Act
OSD PIF	OSD Productivity Capital Investment Funding
PCIP	Productivity Capital Investment Program
PDB	Project Document Brochure
PECIP	Productivity Enhancing Capital Investment Program
POC	Point of Contact
QRIP	Quick Return on Investment Program
SCADA	Supervisory Control And Data Acquistion System
SIR	Savings Investment Ratios
TCX	Technical Center of Expertise
UEMCS	Utility Energy Monitoring Control System
UMCS	Utility Monitoring Control System

APPENDIX B

CORRESPONDENCE

SYSTEMS*corp*
SYSTEMS ENGINEERING AND MANAGEMENT CORPORATION

COMMANDER, U.S. Army Engineer District, Louisville
Attention: CEORL-ED-MS/Charles Lockman, Room 973
600 Dr. Martin King Place
Louisville, Kentucky 40201-0059

Dear Mr. Lockman:

RE: UMCS/SCADA at Fort Campbell, Kentucky
Systems Corp Project #94013.08

We request approval to proceed with the final report of UMCS/SCADA Feasibility Study. Systems Corp believes that we have satisfied all the requirements in the Scope of Work, and have addressed and resolved all of the issues raised by the reviewers. Enclosed for your review are the changes to the report resulting from the Pre-Final Report Review and Mr. Anthony Battaglia's additional review comments. This submission includes:

1. *Pre-Final Review Comments.* These comments were resolved at the Pre-Final Meeting with the exception of Mr. Anthony Battaglia's comments which applied specifically to *Section 3.0*, and are addressed separately for your final review.

2. *Mr. Anthony Battaglia's additional review comments and responses.* Systems Corp revisited the sites at Fort Campbell on December 21, 1995, to obtain additional field data to refine the report analysis. The results should improve the accuracy of the report to your satisfaction.

3. *Section 3.0, HVAC Systems with modified method of calculations, refined assumptions, and expanded explanations.*

4. *Appendix C's associated calculation tables for HVAC systems.*

5. *Section 1.0, Executive Summary.* This section shows the final results of the life-cycle cost analysis after all the changes were incorporated.

Sincerely;

Systems Corp

Komson Wagner, P.E.
Project Manager

MW:jal
Enclosure
cc: Tony Battaglia

Cherokee Place • Suite 306 • 2200 Sutherland Avenue • Knoxville, Tennessee 37919
Telephone (423) 521-6536 Fax (423) 524-7514

SYSTEMS*corp*

SYSTEMS ENGINEERING AND MANAGEMENT CORPORATION

September 21, 1995

US Army Engineer District, Louisville
ATTN: CEORL-ED-MS / Charles Lockman
P. O. Box 59 (express-600 Dr. Martin King Place)
Louisville, KY 40201-0059

Dear Mr. Lockman:

RE: 60% Review Meeting Minutes
Feasibility Study, FY95S EEAP, Utility Monitoring & Control System (UMCS) / Supervisory Control and Data Acquisition (SCADA) System - Fort Campbell, KY

Attendance:

Chuck Lockman	Louisville District, CEORL-ED-MS
Kenneth W. Campbell	CEO-Huntsville,
Naresh Kapur	HQ FORSCOM
William C. Thomas	Fort Campbell DPW, ENV DIV
Arlin Wright	Fort Campbell DPW, ERMD-MESB
Len May	Fort Campbell DPW, ERMD
William D. Henson	Fort Campbell DPW, EMCS
Keith Derrington	Systems Corp, President
Komson Wagner	Systems Corp, Project Manager
Greg Loflin	Systems Corp, Project Manager
Claud Monroe	Systems Corp, Project Manager

The 60% Review Meeting on Fort Campbell's UMCS/SCADA Feasibility Study was held on September 12, 1995 from 09:00 to 12:30 in a DPW Conference Room at Fort Campbell, Kentucky. The following topics were discussed:

1. The meeting started with the introduction of the attendees and the meeting agenda.

2. Systems Corp started the agenda with the presentation of the feasibility study. Analysis methods and assumptions on each of the UMCS/SCADA system applications were discussed. Questions and comments were taken and discussed during the presentation.

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3. The presentation was followed by a discussion of review comments received by Systems Corp prior to the meeting. The comments were covered item by item. Systems Corp addressed comments with satisfactory explanations and clarifications. Improved direction and suggestions were derived from the discussion.

4. Meeting results:

   a. By consensus among the representatives at the meeting, the feasibility study is to proceed to a Pre-final Report submittal with all review comments incorporated. The **Final Report submittal date of November 23, 1995**, remains unchanged. The changes incorporated in the Pre-final Report will be highlighted with a different font for ease of review. **(Systems Corp will submit the Pre-final Report on October 25, 1995. The current date for the Pre-final Review Meeting is November 8, 1995, at Fort Campbell.)**

   b. Systems Corp concurs to clarify and expand the explanation of the analysis methodology in the Pre-final Report.

   c. Systems Corp will contact the reviewers to discuss the unresolved items pertaining to methodology and assumptions applied to energy savings calculations of facilities without the use of computer model simulation.

   d. Systems Corp agrees to incorporate the savings from the flight simulator facilities into the life-cycle cost analysis.

   e. Systems Corp will re-evaluate the application of UMCS/SCADA control methods on the barracks facilities.

   f. Systems Corp will include the savings from reduction of manpower productivity loss due to power outage by utilizing the UMCS/SCADA system to minimize the power outage time. The savings will be incorporated into the life-cycle cost analysis as applied to the power substations which will improve the payback period.

   g. Systems Corp concurs with other minor and miscellaneous items: wording, typing errors, study references, etc.

If you have any questions or comments regarding this material, please do not hesitate to contact me at (423) 521-6536.

Sincerely,

SYSTEMS CORP

Komson (Mak) Wagner
Project Engineer

KW:jal

cc: Arlin E. Wright
Naresh Kapur
Tony Battaglia
Chuck Holland
Admin. File

CEORL-ED-MS

July 31, 1995

FY95S EEAP, FEASIBILITY STUDY

UMCS/SCADA

60% REVIEW MEETING

September 12, 1995

1. The 60% Review Meeting will be held on Tuesday at 0900 (Central), September 12, 1995 in a DPW Conference Room, DPW Building T-868 located at 16th & Ohio Street, Fort Campbell, KY. Gate 3 is the nearest to the meeting site.

2. Agenda:
   a. Meeting Roster sign in, introductions, and provide Systems Corp with your written comments that were not sent prior to the meeting.
   b. Systems Corps (A/E), presentation of the study based on the SOW, dated March 21, 1995.
   c. Question and open discussion time.

3. Three days prior to the review meeting the MCX, TCX, MACOM, DPW, and USACE should have sent written comments. Furnish your comments by fax message to Systems Corp and the Louisville District, so that the A/E can address those concerns at the meeting. Systems Corp has scheduled their 60% Review Submittal on August 18, 1995.

5. Systems Corp fax is (615) 524-7514, and Louisville Districts fax is (502) 582-6763, or "Internet" mail at clockman@smtp.orl.usace.mil.

6. The duration of the meeting is anticipated to last longer than a normal briefing meeting.

Chuck Lockman

CHUCK LOCKMAN, CEORL-ED-MS
(502) 582-6041

CF: MCX, TCX, MACOM, DPW,
Systems Corp., & COE-R.Pepper,
J.McIntyre, K.Rogan

SYSTEMScorp

SYSTEMS ENGINEERING AND MANAGEMENT CORPORATION

June 12, 1995

US Army Engineer District, Louisville
ATTN: CEORL-ED-MS (Charles Lockman)
P. O. Box 59 (express-600 Dr. Martin King Place)
Louisville, KY 40201-0059

Dear Mr. Lockman:

RE: Entry Interview Meeting Minutes
Feasibility Study, FY95S EEAP, Utility Monitoring & Control System (UMCS) / Supervisory Control and Data Acquisition (SCADA) System - Fort Campbell, KY

Attendance:

Chuck Lockman:	Louisville District, CEORL-ED-MS
Arlin Wright:	Fort Campbell DPW, ERMD-MESB
Len May:	Fort Campbell DPW, ERMD
Tom Dunn:	Fort Campbell DPW, Exterior Electric
William Henson:	Fort Campbell DPW, Control
Keith Derrington:	Systems Corp, Principal in Charge
Komson Wagner:	Systems Corp, Project Engineer
Wayne Rose:	Systems Corp, Mechanical Engineer

The Entry Interview Meeting with Fort Campbell and Louisville District was held on May 23, 1995 in a DPW Conference Room at Fort Campbell, KY. The following topics were discussed:

1. Mr. Derrington opened the meeting. He discussed the Scope of the project to get a full understanding of the intent and went over major items listed in the Scope. The points emphasized by Fort Campbell were:

    a. The traffic signals are to be incorporated in the UMCS for monitor and control.
    b. Emergency generators are to be monitored for run time and critical alarms. They should have remote capability for start/stop control.
    c. Underground storage tanks are to be monitored for alarm and volume level.
    d. Substations are to be monitored for load condition, current voltage, kW, kWh, and power factor.
    e. Red River's water pump station is to be put on UMCS.

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2. Fort Campbell representatives described the general condition of the existing EMCS and the FM systems. It was general consent that the front end of the EMCS system was outdated and needed to be replaced with a more user friendly, consolidated system. The FM field control switches are currently being surveyed for serviceability by another project. The EMCS is used mainly to turn the loads on and off; no analog control is being performed.

3. Point of contacts were conveyed to Systems Corp for each system to be investigated at Fort Campbell.

4. Systems Corp provided a list of its personnel who will be involved in the project.

5. Systems Corp obtained general data and began the survey after the meeting was completed.

If you have any questions or comments regarding this material, please do not hesitate to contact me at (615) 521-6536.

Sincerely,

SYSTEMS CORP

Komson Wagner

Komson (Mak) Wagner, P.E.
Project Manager

MW:jal

cc: Arlin E. Wright, AFZB-DPW-MESB
R. B. Maynor, FCEN-RDF
Tony Battaglia, CESAM-EN-CC
Chuck Holland, CEHND-ED-ME-T

B-7

SYSTEMScorp

SYSTEMS ENGINEERING AND MANAGEMENT CORPORATION

June 12, 1995

US Army Engineer District, Louisville
ATTN: CEORL-ED-MS (Charles Lockman)
P. O. Box 59 (express-600 Dr. Martin King Place)
Louisville, KY 40201-0059

Dear Mr. Lockman:

RE: Exit Interview Meeting Minutes
Feasibility Study, FY95S EEAP, Utility Monitoring & Control System (UMCS) / Supervisory Control and Data Acquisition (SCADA) System - Fort Campbell, KY

Attendance:

Len May:	Fort Campbell DPW, ERMD
Keith Derrington:	Systems Corp, Principal incharge
Komson Wagner:	Systems Corp, Project Engineer
Greg Loflin:	Systems Corp, Mechanical Engineer
Wayne Rose:	Systems Corp, Mechanical Engineer

The Exit Interview Meeting with Fort Campbell and Louisville District was held on June 8, 1995 in Mr. May's office at Fort Campbell, KY. The following topics were discussed:

1. Systems Corp informed Fort Campbell that the field survey portion of the project had been successfully completed. Systems Corp will now begin to perform the evaluation and analysis phase of the project.

2. An Interim Review Meeting is scheduled for the month of August. System Corp will coordinate the exact date with Fort Campbell.

If you have any questions or comments regarding this material, please do not hesitate to contact me at (615) 521-6536.

Sincerely,

SYSTEMS CORP

Komson Wagner

Komson (Mak) Wagner, P.E.
Project Manager

KW:jal

cc: Arlin E. Wright, AFZB-DPW-MESB
R. B. Maynor, FCEN-RDF
Tony Battaglia, CESAM-EN-CC
Chuck Holland, CEHND-ED-ME-T

C:\LEE\WPWIN\94013.08\61395.LET

Cherokee Place • Suite 306 • 2200 Sutherland Avenue • Knoxville, Tennessee 37919
Telephone (615) 521-6536 Fax (615) 524-7514

CEORL-ED-MS May 9, 1995

FY95S EEAP, FEASIBILITY STUDY

UMCS/SCADA
ENTRY INTERVIEW MEETING

@ FORT CAMPBELL, KY.
MAY 23, 1995 @ 8:30AM

1. The Entry Interview Meeting with Systems Corp (A/E) of Knoxville, TN. will be held on Tuesday at 8:30am (Central), May 23, 1995 in a DPW Conference Room, BLDG. T-868 @ 16th & Ohio Street.

2. Agenda:

a. A/E will advise the installation regarding when they will conduct their field investigations.
b. A/E will provide a list of their personnel that will be on the installation doing the field investigations.
c. A/E will present their study plan.
d. Questions and guideances from the installation can be advised and gathered at this time.

3. The USACE, and Systems Corp (A/E) of Knoxville, TN., Mr. Wright DPW, and others from the installation would be the attendees for the entrance interview.

4. The A/E advises the USACE that the meeting may take a while in order to review what they summize their UMCS/SCADA study will consist of, and advisory suggestions from the installation would be required.

5. If you have any questions for the Louisville District about the meeting you may call (501) 582-6763, Chuck Lockman, ED-MS.

CHUCK LOCKMAN, CEORL-ED-MS
(502) 582-6040, fax #6763

US Army Corps
of Engineers
Louisville District

MEETING ROSTER

CONFERENCE ATTENDANCE LIST

PROJECT FY95S EEAP FEASIBILITY STUDY, UMCS/SCADA,

LOCATION DPW Conference Room, Fort Campbell, KY

DATE May 23, 1995 @0830

NAME:	TITLE:	ORGANIZATION:	TELEPHONE NO. & FAX#
Chuck Lockman	COR & P.E.	CEORL-ED-MS	502-582-6041 Fax #6763
ARLIN E. WRIGHT	Sup. Ind Engr	DPW-ERMD-MESB	502-798-8895 FAX 7840
Len May	Ch, ERMD	DPW	502-798-8994
Mak Wagner	Project Eng.	Systems Corps	615-581-6536
KEITH A. DERRINGTON	PRINCIPAL IN CHARGE	Systems Corp	615-521-6536
GREG LOFLIN	MECH. ENG.	SYSTEMS CORP	615-521-6536
WAYNE ROSE	MECH ENG	SYSTEMS CORP	615-521-6536
William Henson	Electronic Control mech	DPW	(502) 798-3913
Tom Dunn	Su PEK-u Sur EX-ELECT.	DPW	502-798-2119

CEORL-ED-MS

March 9, 1995

FY95S EEAP, FEASIBILITY STUDY
UMCS/SCADA
PRE-NEGOTIATION SCOPING MEETING @ FORT CAMPBELL,KY.
MARCH 21, 1995

1. A Pre-Negotiation Scoping Meeting will be held on Tuesday at 1000 (Central), March 21, 1995 in a DPW Conference Room, BLDG. T-868 @ 16th & Ohio Street.

2. Agenda:
   a. Meeting Roster sign in & Introductions.
   b. Introduction of Systems Corp (A/E), and the study based on the SOW, dated March 8, 1995.
   c. A/E's presentation of their study plan.
   d. Question and answer time.
   e. A Conclusion of meeting.

3. The MACOM, MCX, TCX, DPW, COE, and Systems Corp (A/E) of Knoxville, TN., and others at the installation are invited to attend the meeting to combine thoughts, and project directions for the finalization of Scope of Work.

4. Prior to the meeting the Scope of Work, dated March 8, 1995, which has already been reviewed by DPW, COE, MACOM, CERL, BATTELLE, and others, was formulated as a result from the meeting held at the installation on February 14, 1995. Prior to the meeting the Scope of Work is furnished to under separate cover for your advance knowledge of the work required by System Corp to study the UMCS/SCADA.

5. If you want to make advanced additions and comments regarding the scope, you may fax those changes to the Louisville District, (501) 582-6763, attention Chuck Lockman, ED-MS.

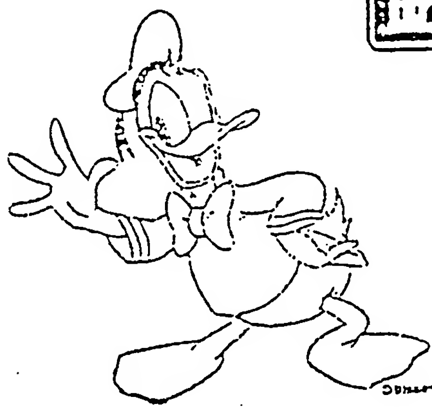
6. We are recommending the Conclusion of meeting be no later than 1130 so that out of town attendees can travel back to their offices on March 21, 1995.

Chuck Lockman

CHUCK LOCKMAN, CEORL-ED-MS
(502) 582-6040, fax #6763

US Army Corps of Engineers
Louisville District
A/E Support Section

FROM:



CHUCK LOCKMAN
502-582-6041 or fax#6763
MASTER PLANNER/PROJECT ENGINEER

ATTN: CEORL-ED-MS
P.O. Box 59
Louisville, KY 40201-0059

TO: ________ ATTN: KEITH DERRINGTON 615 521-6536
PRESIDENT
Office / Locatic ________
FAX Number: ________ S. CORP 615 524-7514

Classification: FOUO / UUUU
Priority: ASAP / Routine
Number of Pages (incl header sheet): ____

SUBJECT: 60% Review Meeting, FY95S EEAP F.S. UMCS/SCADA, Fort Campbell, KY

1. Attached is the meeting announcement for the subject.

2. Your comments are vital for the subject.

3. We look forward to having the whole review team at the meeting on September 12, 1995.

4. Please schedule your time for the review, and your travel for the FY ending month of September.

APPENDIX C: CALCULATIONS & ESTIMATES

APPENDIX C

CALCULATIONS & ESTIMATES

UMCS/SCADA PROJECT LIFE-CYCLE ANALYSIS

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

STUDY: SCADA
LCCID FY95 (92)

INSTALLATION & LOCATION: FORT CAMPBELL REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: 94013.08 FEASIBILITY STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: UMCS/SCADA
ANALYSIS DATE: 01-02-96 ECONOMIC LIFE 10 YEARS PREPARED BY: KW

1. INVESTMENT

A. CONSTRUCTION COST	$ 4480018.		
B. SIOH	$ 224001.		
C. DESIGN COST	$ 224001.		
D. TOTAL COST (1A+1B+1C)	$ 4928020.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 4928020.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 6.19	3298.	$ 20415.	8.58	$ 175157.
B. DIST	$ 5.62	-10332.	$ -58066.	9.62	$ -558593.
C. RESID	$ .00	0.	$ 0.	10.53	$ 0.
D. NAT G	$ 4.35	84720.	$ 368532.	9.60	$ 3537907.
E. COAL	$ .00	0.	$ 0.	9.28	$ 0.
F. PPG	$ .00	0.	$ 0.	9.28	$ 0.
M. DEMAND SAVINGS			$ 510629.	8.53	$ 4355665.
N. TOTAL		77686.	$ 841510.		$ 7510137.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 382538.
(1) DISCOUNT FACTOR (TABLE A) 8.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 3263049.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
1. REPLACEMENT	$1118355.	5	.86	961785.
2. AVOIDANCE	$ 125000.	5	.86	107500.
d. TOTAL	$1243355.			1069285.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 4332335.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 1348383.

5. SIMPLE PAYBACK PERIOD (1G/4) 3.65 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 11842470.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 2.40
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 12.44 %

*** MeansData Estimate ***

Estimate:	SCADA	Date:	
Description:	HEADEND/NETWORK		
Project:	SCADA	Bid Date:	
Location:	FT CAMPBELL	Job #:	
Sq. footage:		City indx:	

Line #	Description					$778,914
	Manhours	Matl	Labor	Equipment	Sub	Total
1611370150	FIBER OPTIC JUMPER					
					60.00 Ea.	
Unit values	0.00	55.50	0.00	0.00	0.00	55.50
Totals	0.00	$3,330	$0	$0	$0	$3,330
1611370200	FIBER OPTIC PIGTAIL					
					60.00 Ea.	
Unit values	0.00	30.00	0.00	0.00	0.00	30.00
Totals	0.00	$1,800	$0	$0	$0	$1,800
1611370300	FIBER OPTIC CONNECTOR					
					120.00 Ea.	
Unit values	0.33	20.00	9.15	0.00	0.00	29.15
Totals	39.96	$2,400	$1,098	$0	$0	$3,498
1611370350	FIBER OPTIC FINGER SPLICE					
					60.00 Ea.	
Unit values	0.25	32.00	6.90	0.00	0.00	38.90
Totals	15.00	$1,920	$414	$0	$0	$2,334
1611370400	TRANSCEIVER (LOW COST BI-DIRECTIONAL)					
					12.00 Ea.	
Unit values	1.00	290.00	27.50	0.00	0.00	317.50
Totals	12.00	$3,480	$330	$0	$0	$3,810
1699000005	FILE SERVER PENTIUM 120, 2GB HD,400MB TAPE DR					
	17" SVGA, 64 MB RAM				1.00 EA	
Unit values	0.00	6763.00	100.00	0.00	0.00	6863.00
Totals	0.00	$6,763	$100	$0	$0	$6,863
1699000010	WORK STATION, PENTIUM 120, 540 MB HD					
	17"SVGA, 64 MB RAM				5.00 EA	
Unit values	0.00	5850.00	100.00	0.00	0.00	5950.00
Totals	0.00	$29,250	$500	$0	$0	$29,750
1699000015	UPS 3000VA/LIGHTNING ARRESTER					
					5.00 EA	

Unit values		0.00	1750.00	50.00	0.00	0.00	1800.00
Totals		0.00	$8,750	$250	$0	$0	$9,000
1699000020	LASER PRINTER, 600 DPI						
						5.00 EA	
Unit values		0.00	950.00	25.00	0.00	0.00	975.00
Totals		0.00	$4,750	$125	$0	$0	$4,875
1699000025	CONTROL SOFTWARE, MUTI USER						
	5 SEAT PACKAGE					1.00 EA	
Unit values		0.00	20150.00	0.00	0.00	0.00	20150.00
Totals		0.00	$20,150	$0	$0	$0	$20,150
1699000030	ALARM SOFTWARE, MULTI-USER						
	5 SEAT PACKAGE					1.00 EA	
Unit values		0.00	7500.00	0.00	0.00	0.00	7500.00
Totals		0.00	$7,500	$0	$0	$0	$7,500
1699000035	ENGINEERING/SYSTEM SETUP						
						4000.00 PT	
Unit values		0.00	0.00	65.00	0.00	0.00	65.00
Totals		0.00	$0	$260,000	$0	$0	$260,000
1699000040	FIBER OPTIC SELF SUPPORT CABLE						
	4-FIBER,SINGLE MODE					600.00 CLF	
Unit values		1.00	92.94	28.50	0.00	0.00	121.44
Totals		600.00	$55,764	$17,100	$0	$0	$72,864
1699000045	LANGATE						
						9.00 EA	
Unit values		2.50	2795.00	28.50	0.00	0.00	2823.50
Totals		22.50	$25,155	$257	$0	$0	$25,412
1699000050	THIRD PARTY INTERFACE MODULE						
						25.00 EA	
Unit values		2.50	2500.00	28.50	0.00	0.00	2528.50
Totals		62.50	$62,500	$713	$0	$0	$63,213
1699000055	VHF TRANSCEIVER, MODEL 95						
	66 TO 79 M HZ					20.00 EA	
Unit values		2.50	1695.00	28.50	0.00	0.00	1723.50
Totals		50.00	$33,900	$570	$0	$0	$34,470
1699000060	ANTENNA, VHF, 1/4W , BUILDING MOUNT						
						20.00 EA	
Unit values		1.00	115.00	28.50	0.00	0.00	143.50
Totals		20.00	$2,300	$570	$0	$0	$2,870
U16 ELECTRICAL		822	$269,712	$282,027	$0	$0	$551,739

	Manhours	Matl	Labor	Equipment	Sub	Total
ESTIMATE TOTAL	822	$269,712	$282,027	$0	$0	$551,739

SUMMARY

	Manhours	Matl	Labor	Equipment	Sub	Total
U16 ELECTRICAL	822	$269,712	$282,027	$0	$0	$551,739
TOTAL	822	$269,712	$282,027	$0	$0	$551,739
SALES TAX	5.50%	$14,834				
MATL MARKUP	10.00%	$26,971				
LABOR MARKUP	15.00%		$42,304			
EQUIPT MARKUP	0.00%			$0		
SUB MARKUP	0.00%				$0	
TOTAL BEFORE CONTINGENCY		$311,517	$324,331	$0	$0	$635,848
CONTINGENCY	10.00%					$63,585
BOND	2.50%					$15,896
PROFIT	10.00%					$63,585
JOB TOTAL						$778,914

ECO 1:
FACILITY HVAC SYSTEMS

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
STUDY: SCADA
LCCID FY95 (92)
INSTALLATION & LOCATION: FORT CAMPBELL REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: 94013.08 FEASIBILITY STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: ECO-1
ANALYSIS DATE: 01-02-96 ECONOMIC LIFE 10 YEARS PREPARED BY: KW

1. INVESTMENT

A.	CONSTRUCTION COST	$ 2044978.		
B.	SIOH	$ 102250.		
C.	DESIGN COST	$ 102250.		
D.	TOTAL COST (1A+1B+1C)	$ 2249478.		
E.	SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F.	PUBLIC UTILITY COMPANY REBATE		$ 0.	
G.	TOTAL INVESTMENT (1D - 1E - 1F)			$ 2249478.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 6.19	2983.	$ 18465.	8.58	$ 158428.
B. DIST	$ 5.62	0.	$ 0.	9.62	$ 0.
C. RESID	$ .00	0.	$ 0.	10.53	$ 0.
D. NAT G	$ 4.35	84720.	$ 368532.	9.60	$ 3537907.
E. COAL	$ .00	0.	$ 0.	9.28	$ 0.
F. PPG	$ .00	0.	$ 0.	9.28	$ 0.
M. DEMAND SAVINGS			$ 19551.	8.53	$ 166770.
N. TOTAL		87703.	$ 406548.		$ 3863105.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)		$ 47200.
(1) DISCOUNT FACTOR (TABLE A)	8.53	
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$ 402616.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
1. REPLACEMENT	$1104655.	5	.86	950003.
d. TOTAL	$1104655.			950003.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 1352619.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 564213.

5. SIMPLE PAYBACK PERIOD (1G/4) 3.99 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 5215724.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 2.32
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 12.04 %

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
STUDY: SCADA
LCCID FY95 (92)
INSTALLATION & LOCATION: FORT CAMPBELL REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: 94013.08 FEASIBILITY STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: ECO-1A
ANALYSIS DATE: 01-02-96 ECONOMIC LIFE 10 YEARS PREPARED BY: KW

1. INVESTMENT

A. CONSTRUCTION COST	$ 462070.		
B. SIOH	$ 23104.		
C. DESIGN COST	$ 23104.		
D. TOTAL COST (1A+1B+1C)	$ 508278.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 508278.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 6.19	730.	$ 4519.	8.58	$ 38770.
B. DIST	$ 5.62	0.	$ 0.	9.62	$ 0.
C. RESID	$ .00	0.	$ 0.	10.53	$ 0.
D. NAT G	$ 4.35	34261.	$ 149035.	9.60	$ 1430739.
E. COAL	$ .00	0.	$ 0.	9.28	$ 0.
F. PPG	$ .00	0.	$ 0.	9.28	$ 0.
M. DEMAND SAVINGS			$ 12718.	8.53	$ 108485.
N. TOTAL		34991.	$ 166272.		$ 1577994.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)		$ 0.
(1) DISCOUNT FACTOR (TABLE A)	8.53	
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-) (4)
1. REPLACEMENT	$ 155325.	5	.86	133580.
d. TOTAL	$ 155325.			133580.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 133580.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 181805.

5. SIMPLE PAYBACK PERIOD (1G/4) 2.80 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 1711574.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 3.37
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 16.30 %

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
STUDY: SCADA
LCCID FY95 (92)
INSTALLATION & LOCATION: FORT CAMPBELL REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: 94013.08 FEASIBILITY STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: ECO-1B
ANALYSIS DATE: 01-02-96 ECONOMIC LIFE 10 YEARS PREPARED BY: KW

1. INVESTMENT

A. CONSTRUCTION COST	$ 547660.		
B. SIOH	$ 27383.		
C. DESIGN COST	$ 27383.		
D. TOTAL COST (1A+1B+1C)	$ 602426.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 602426.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 6.19	270.	$ 1671.	8.58	$ 14340.
B. DIST	$ 5.62	0.	$ 0.	9.62	$ 0.
C. RESID	$ .00	0.	$ 0.	10.53	$ 0.
D. NAT G	$ 4.35	24556.	$ 106819.	9.60	$ 1025459.
E. COAL	$ .00	0.	$ 0.	9.28	$ 0.
F. PPG	$ .00	0.	$ 0.	9.28	$ 0.
M. DEMAND SAVINGS			$ 6833.	8.53	$ 58285.
N. TOTAL		24826.	$ 115323.		$ 1098084.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 15680.
(1) DISCOUNT FACTOR (TABLE A) 8.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 133750.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
1. REPLACEMENT	$ 234280.	5	.86	201481.
d. TOTAL	$ 234280.			201481.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 335231.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 154431.

5. SIMPLE PAYBACK PERIOD (1G/4) 3.90 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 1433315.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 2.38
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 12.33 %

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
STUDY: SCADA
LCCID FY95 (92)
INSTALLATION & LOCATION: FORT CAMPBELL REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: 94013.08 FEASIBILITY STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: ECO-1C
ANALYSIS DATE: 01-02-96 ECONOMIC LIFE 10 YEARS PREPARED BY: KW

1. INVESTMENT			
A. CONSTRUCTION COST	$ 277699.		
B. SIOH	$ 13885.		
C. DESIGN COST	$ 13885.		
D. TOTAL COST (1A+1B+1C)	$ 305469.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 305469.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 6.19	116.	$ 718.	8.58	$ 6161.
B. DIST	$ 5.62	0.	$ 0.	9.62	$ 0.
C. RESID	$ .00	0.	$ 0.	10.53	$ 0.
D. NAT G	$ 4.35	5499.	$ 23921.	9.60	$ 229638.
E. COAL	$ .00	0.	$ 0.	9.28	$ 0.
F. PPG	$ .00	0.	$ 0.	9.28	$ 0.
M. DEMAND SAVINGS			$ 0.	8.53	$ 0.
N. TOTAL		5615.	$ 24639.		$ 235799.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)		$ 4000.
(1) DISCOUNT FACTOR (TABLE A)	8.53	
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$ 34120.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
1. REPLACEMENT	$ 127535.	5	.86	109680.
d. TOTAL	$ 127535.			109680.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 143800.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 41392.

5. SIMPLE PAYBACK PERIOD (1G/4) 7.38 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 379599.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.24
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 5.26 %

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: SCADA
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT CAMPBELL REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: 94013.08 FEASIBILITY STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: ECO-1D
ANALYSIS DATE: 01-02-96 ECONOMIC LIFE 10 YEARS PREPARED BY: KW

1. INVESTMENT

A. CONSTRUCTION COST	$ 167475.		
B. SIOH	$ 8374.		
C. DESIGN COST	$ 8374.		
D. TOTAL COST (1A+1B+1C)	$ 184223.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 184223.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 6.19	45.	$ 279.	8.58	$ 2390.
B. DIST	$ 5.62	0.	$ 0.	9.62	$ 0.
C. RESID	$ .00	0.	$ 0.	10.53	$ 0.
D. NAT G	$ 4.35	2258.	$ 9822.	9.60	$ 94294.
E. COAL	$ .00	0.	$ 0.	9.28	$ 0.
F. PPG	$ .00	0.	$ 0.	9.28	$ 0.
M. DEMAND SAVINGS			$ 0.	8.53	$ 0.
N. TOTAL		2303.	$ 10101.		$ 96684.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 4800.
(1) DISCOUNT FACTOR (TABLE A) 8.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 40944.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
1. REPLACEMENT	$ 76958.	5	.86	66184.
d. TOTAL	$ 76958.			66184.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 107128.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 22597.

5. SIMPLE PAYBACK PERIOD (1G/4) 8.15 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 203812.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.11
(IF < 1 PROJECT DOES NOT QUALIFY)
**** Project does not qualify for ECIP funding; 4,5,6 for information only.

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): N/A

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
STUDY: SCADA
LCCID FY95 (92)
INSTALLATION & LOCATION: FORT CAMPBELL REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: 94013.08 FEASIBILITY STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: ECO-1E
ANALYSIS DATE: 01-02-96 ECONOMIC LIFE 10 YEARS PREPARED BY: KW

1.	INVESTMENT			
A.	CONSTRUCTION COST	$ 96640.		
B.	SIOH	$ 4832.		
C.	DESIGN COST	$ 4832.		
D.	TOTAL COST (1A+1B+1C)	$ 106304.		
E.	SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F.	PUBLIC UTILITY COMPANY REBATE		$ 0.	
G.	TOTAL INVESTMENT (1D - 1E - 1F)			$ 106304.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 6.19	15.	$ 93.	8.58	$ 797.
B. DIST	$ 5.62	0.	$ 0.	9.62	$ 0.
C. RESID	$ .00	0.	$ 0.	10.53	$ 0.
D. NAT G	$ 4.35	1888.	$ 8213.	9.60	$ 78843.
E. COAL	$ .00	0.	$ 0.	9.28	$ 0.
F. PPG	$ .00	0.	$ 0.	9.28	$ 0.
M. DEMAND SAVINGS			$ 0.	8.53	$ 0.
N. TOTAL		1903.	$ 8306.		$ 79640.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 1920.
(1) DISCOUNT FACTOR (TABLE A) 8.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 16378.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
1. REPLACEMENT	$ 29460.	5	.86	25336.
d. TOTAL	$ 29460.			25336.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 41713.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 13172.

5. SIMPLE PAYBACK PERIOD (1G/4) 8.07 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 121353.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.14
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): N/A

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
STUDY: SCADA
LCCID FY95 (92)
INSTALLATION & LOCATION: FORT CAMPBELL REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: 94013.08 FEASIBILITY STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: ECO-1F
ANALYSIS DATE: 01-02-96 ECONOMIC LIFE 10 YEARS PREPARED BY: KW

1. INVESTMENT

A. CONSTRUCTION COST	$ 124500.		
B. SIOH	$ 6225.		
C. DESIGN COST	$ 6225.		
D. TOTAL COST (1A+1B+1C)	$ 136950.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 136950.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 6.19	840.	$ 5200.	8.58	$ 44613.
B. DIST	$ 5.62	0.	$ 0.	9.62	$ 0.
C. RESID	$ .00	0.	$ 0.	10.53	$ 0.
D. NAT G	$ 4.35	9170.	$ 39890.	9.60	$ 382939.
E. COAL	$ .00	0.	$ 0.	9.28	$ 0.
F. PPG	$ .00	0.	$ 0.	9.28	$ 0.
M. DEMAND SAVINGS			$ 0.	8.53	$ 0.
N. TOTAL		10010.	$ 45089.		$ 427552.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)		$ 12800.
(1) DISCOUNT FACTOR (TABLE A)	8.53	
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$ 109184.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
1. REPLACEMENT	$ 55470.	5	.86	47704.
d. TOTAL	$ 55470.			47704.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 156888.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 63436.

5. SIMPLE PAYBACK PERIOD (1G/4) 2.16 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 584440.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 4.27
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 19.08 %

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
STUDY: SCADA
LCCID FY95 (92)
INSTALLATION & LOCATION: FORT CAMPBELL REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: 94013.08 FEASIBILITY STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: ECO-1G
ANALYSIS DATE: 01-02-96 ECONOMIC LIFE 10 YEARS PREPARED BY: KW

1. INVESTMENT

A. CONSTRUCTION COST	$ 368934.		
B. SIOH	$ 18446.		
C. DESIGN COST	$ 18446.		
D. TOTAL COST (1A+1B+1C)	$ 405826.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 405826.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 6.19	967.	$ 5986.	8.58	$ 51358.
B. DIST	$ 5.62	0.	$ 0.	9.62	$ 0.
C. RESID	$ .00	0.	$ 0.	10.53	$ 0.
D. NAT G	$ 4.35	7088.	$ 30833.	9.60	$ 295995.
E. COAL	$ .00	0.	$ 0.	9.28	$ 0.
F. PPG	$ .00	0.	$ 0.	9.28	$ 0.
M. DEMAND SAVINGS			$ 0.	8.53	$ 0.
N. TOTAL		8055.	$ 36819.		$ 347352.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 8000.
(1) DISCOUNT FACTOR (TABLE A) 8.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 68240.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
1. REPLACEMENT	$ 425627.	5	.86	366039.
d. TOTAL	$ 425627.			366039.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 434279.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 87381.

5. SIMPLE PAYBACK PERIOD (1G/4) 4.64 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 781632.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.93
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 9.98 %

Estimate:	60-80 POINTS	Date:	07 AUG 1995
Description:	TYPICAL FACILITY (UMCS-HVAC SYSTEMS POINTS)		
Project:	UMCS/SCADA	Bid Date:	
Location:	FT. CAMPBELL, KY	Job #:	SYSTEMS CORP #94013.08
Sq. footage:	1850.00	City indx:	Louisville, KY

Line #	Description					$33,696
	Manhours	Matl	Labor	Equipment	Sub	Total
1574220001	DDC CONTROL MODULE : G 01010 P					
					1.00 EA	
Unit values	4.00	1750.00	100.00	0.00	0.00	1850.00
Totals	4.00	$1,750	$100	$0	$0	$1,850
1574220002	DDC CONTROL MODULE EXPANDER : X 01010 P					
					1.00 EA	
Unit values	4.00	1750.00	100.00	0.00	0.00	1850.00
Totals	4.00	$1,750	$100	$0	$0	$1,850
1574220003	DDC CONTROL MODULE EXPANDER : X 4106 P					
					1.00 EA	
Unit values	4.00	1650.00	100.00	0.00	0.00	1750.00
Totals	4.00	$1,650	$100	$0	$0	$1,750
1574220004	Z 540					
					7.00 EA	
Unit values	3.00	162.50	75.00	0.00	0.00	237.50
Totals	21.00	$1,138	$525	$0	$0	$1,663
1574220005	TRANSDUCER					
					7.00 EA	
Unit values	0.00	142.85	0.00	0.00	0.00	142.85
Totals	0.00	$1,000	$0	$0	$0	$1,000
1574220006	ROOM SENSORS					
					27.00 EA	
Unit values	1.00	24.00	25.00	0.00	0.00	49.00
Totals	27.00	$648	$675	$0	$0	$1,323
1574220007	LEXAN ENCLOSURES					
					7.00 EA	
Unit values	1.00	10.00	25.00	0.00	0.00	35.00
Totals	7.00	$70	$175	$0	$0	$245

Estimate:	60-80 POINTS	Date:	07 AUG 1995
Description:	TYPICAL FACILITY (UMCS-HVAC SYSTEMS POINTS)		
Project:	UMCS/SCADA	Bid Date:	
Location:	FT. CAMPBELL, KY	Job #:	SYSTEMS CORP #94013.08
Sq. footage:	1850.00	City indx:	Louisville, KY

Line #	Description					$33,696
	Manhours	Matl	Labor	Equipment	Sub	Total
1574220008	AIR SENSORS				11.00 EA	
Unit values	1.00	56.00	25.00	0.00	0.00	81.00
Totals	11.00	$616	$275	$0	$0	$891
1574220009	STATIC SENSOR				1.00 EA	
Unit values	1.00	200.00	25.00	0.00	0.00	225.00
Totals	1.00	$200	$25	$0	$0	$225
1574220010	STATIC PRESSURE				1.00 EA	
Unit values	4.00	140.00	100.00	0.00	0.00	240.00
Totals	4.00	$140	$100	$0	$0	$240
1574220011	KUP				11.00 EA	
Unit values	0.50	13.00	12.50	0.00	0.00	25.50
Totals	5.50	$143	$138	$0	$0	$281
1574220012	NEMA 12 12" X 12" X 6" ENCLOSURE				7.00 EA	
Unit values	3.00	100.00	75.00	0.00	0.00	175.00
Totals	21.00	$700	$525	$0	$0	$1,225
1574220013	NEMA 12 48" X 32" ENCLOSURE				1.00 EA	
Unit values	8.00	460.00	200.00	0.00	0.00	660.00
Totals	8.00	$460	$200	$0	$0	$660
1574220014	A 492 AVG KIT				11.00 EA	
Unit values	0.50	16.00	25.00	0.00	0.00	41.00
Totals	5.50	$176	$275	$0	$0	$451

Estimate:	60-80 POINTS	Date:	07 AUG 1995
Description:	TYPICAL FACILITY (UMCS-HVAC SYSTEMS POINTS)		
Project:	UMCS/SCADA	Bid Date:	
Location:	FT. CAMPBELL, KY	Job #:	SYSTEMS CORP #94013.08
Sq. footage:	1850.00	City indx:	Louisville, KY

Line #	Description					$33,696
	Manhours	Matl	Labor	Equipment	Sub	Total
1574220015	TRANSFORMERS 40KVA					
					7.00 EA	
Unit values	1.00	20.00	25.00	0.00	0.00	45.00
Totals	7.00	$140	$175	$0	$0	$315
1574220016	TRANSFORMERS 75KVA					
					2.00 EA	
Unit values	1.00	37.00	25.00	0.00	0.00	62.00
Totals	2.00	$74	$50	$0	$0	$124
1574220017	TERMINALS					
					120.00 EA	
Unit values	0.10	0.89	2.50	0.00	0.00	3.39
Totals	12.00	$106	$300	$0	$0	$406
1574220018	CABLE TRAY					
					1.00 LOT	
Unit values	1.00	40.00	25.00	0.00	0.00	65.00
Totals	1.00	$40	$25	$0	$0	$65
1574220019	18-2 WIRE					
					2400.00 L.F.	
Unit values	0.01	0.09	0.25	0.00	0.00	0.34
Totals	24.00	$211	$600	$0	$0	$811
1574220020	1/4" COPPER & FITTING					
					1000.00 L.F.	
Unit values	0.02	0.27	0.50	0.00	0.00	0.77
Totals	20.00	$270	$500	$0	$0	$770
1574220021	LIGHTNING PROTECTION					
					1.00 LOT	
Unit values	8.00	150.00	200.00	0.00	0.00	350.00
Totals	8.00	$150	$200	$0	$0	$350

Estimate:	60-80 POINTS	Date:	07 AUG 1995
Description:	TYPICAL FACILITY (UMCS-HVAC SYSTEMS POINTS)		
Project:	UMCS/SCADA	Bid Date:	
Location:	FT. CAMPBELL, KY	Job #:	SYSTEMS CORP #94013.08
Sq. footage:	1850.00	City indx:	Louisville, KY

Line #	Description					$33,696
	Manhours	Matl	Labor	Equipment	Sub	Total
1574220022	3/4" EMT C ONDUIT					
					600.00 L.F.	
Unit values	0.09	1.67	2.21	0.00	0.00	3.88
Totals	53.00	$1,003	$1,325	$0	$0	$2,328
1574220023	#14 THHN WIRING					
					1000.00 L.F.	
Unit values	0.01	0.06	0.16	0.00	0.00	0.22
Totals	6.00	$63	$155	$0	$0	$218
1574220024	MGMNT, TECHN. & CLER. LABOR INCL PROJ INSP & VALID, DRAFT, ETC.				1.00 LOT	
Unit values	80.00	0.00	1800.00	0.00	0.00	1800.00
Totals	80.00	$0	$1,800	$0	$0	$1,800
1574220025	MISC TRAVEL EXPENSES					
					1.00 LOT	
Unit values	0.00	875.00	0.00	0.00	0.00	875.00
Totals	0.00	$875	$0	$0	$0	$875
U15 MECHANICAL	336	$13,373	$8,344	$0	$0	$21,716
ESTIMATE TOTAL	336	$13,373	$8,344	$0	$0	$21,716

Estimate:	60-80 POINTS	Date:	07 AUG 1995
Description:	TYPICAL FACILITY (UMCS-HVAC SYSTEMS POINTS)		
Project:	UMCS/SCADA	Bid Date:	
Location:	FT. CAMPBELL, KY	Job #:	SYSTEMS CORP #94013.08
Sq. footage:	1850.00	City indx:	Louisville, KY

Line #	Description					$33,696
	Manhours	Matl	Labor	Equipment	Sub	Total

SUMMARY

	Manhours	Matl	Labor	Equipment	Sub	Total
U15 MECHANICAL	336	$13,373	$8,344	$0	$0	$21,716
TOTAL	336	$13,373	$8,344	$0	$0	$21,716
SALES TAX	5.50%	$736				
MATL MARKUP	6.00%	$802				
LABOR MARKUP	15.00%		$1,252			
EQUIPT MARKUP	0.00%			$0		
SUB MARKUP	0.00%				$0	
TOTAL BEFORE CONTINGE		$14,911	$9,596	$0	$0	$24,506

Estimate:	20-30 POINTS	Date:	07 AUG 1995
Description:	TYPICAL FACILITY (UMCS-HVAC SYSTEMS POINTS)		
Project:	UMCS/SCADA	Bid Date:	
Location:	FT. CAMPBELL, KY	Job #:	SYSTEMS CORP #94013.08
Sq. footage:	1850.00	City indx:	Louisville, KY

Line #	Description					$11,911
	Manhours	Matl	Labor	Equipment	Sub	Total
1574220003	DDC CONTROL MODULE EXPANDER : X 880					
					1.00 EA	
Unit values	3.00	685.00	75.00	0.00	0.00	760.00
Totals	3.00	$685	$75	$0	$0	$760
1574220004	DDC CONTROL MODULE : G 4106 E					
					1.00 EA	
Unit values	4.00	1650.00	100.00	0.00	0.00	1750.00
Totals	4.00	$1,650	$100	$0	$0	$1,750
1574220005	DAMPER ACTUATOR					
					7.00 EA	
Unit values	1.50	135.00	37.50	0.00	0.00	172.50
Totals	10.50	$945	$263	$0	$0	$1,208
1574220006	VALVE ACTUATOR					
					2.00 EA	
Unit values	4.00	250.00	100.00	0.00	0.00	350.00
Totals	8.00	$500	$200	$0	$0	$700
1574220007	RELAYS					
					4.00 EA	
Unit values	0.50	13.00	12.50	0.00	0.00	25.50
Totals	2.00	$52	$50	$0	$0	$102
1574220008	TRANSFORMER					
					2.00 EA	
Unit values	0.50	18.00	12.50	0.00	0.00	30.50
Totals	1.00	$36	$25	$0	$0	$61
1574220009	TERMINALS					
					40.00 EA	
Unit values	0.10	0.90	2.50	0.00	0.00	3.40
Totals	4.00	$36	$100	$0	$0	$136

Estimate:	20-30 POINTS	Date:	07 AUG 1995
Description:	TYPICAL FACILITY (UMCS-HVAC SYSTEMS POINTS)		
Project:	UMCS/SCADA	Bid Date:	
Location:	FT. CAMPBELL, KY	Job #:	SYSTEMS CORP #94013.08
Sq. footage:	1850.00	City indx:	Louisville, KY

Line #	Description					$11,911
	Manhours	Matl	Labor	Equipment	Sub	Total
1574220010	30" X 24" NEMA 12 ENCLOSURE					
					1.00 EA	
Unit values	4.00	165.00	100.00	0.00	0.00	265.00
Totals	4.00	$165	$100	$0	$0	$265
1574220011	ROOM SENSOR					
					4.00 EA	
Unit values	1.00	24.00	25.00	0.00	0.00	49.00
Totals	4.00	$96	$100	$0	$0	$196
1574220012	18-2 WIRE					
					800.00 L.F.	
Unit values	0.01	0.10	0.25	0.00	0.00	0.35
Totals	8.00	$76	$200	$0	$0	$276
1574220013	H' SENSOR					
					1.00 EA	
Unit values	1.50	145.00	37.50	0.00	0.00	182.50
Totals	1.50	$145	$38	$0	$0	$183
1574220014	MISC. ELECTRICAL					
	INCL. LIGHTNING PROTECTION, WIRE, TRAY				1.00 LOT	
Unit values	8.00	125.00	200.00	0.00	0.00	325.00
Totals	8.00	$125	$200	$0	$0	$325
1574220015	3/4" EMT C ONDUIT					
					100.00 L.F.	
Unit values	0.09	1.63	2.21	0.00	0.00	3.84
Totals	9.00	$163	$225	$0	$0	$388
1574220016	#14 THHN WIRING					
					400.00 L.F.	
Unit values	0.01	0.06	0.16	0.00	0.00	0.22
Totals	2.50	$25	$63	$0	$0	$88

Estimate:	20-30 POINTS	Date:	07 AUG 1995
Description:	TYPICAL FACILITY (UMCS-HVAC SYSTEMS POINTS)		
Project:	UMCS/SCADA	Bid Date:	
Location:	FT. CAMPBELL, KY	Job #:	SYSTEMS CORP #94013.08
Sq. footage:	1850.00	City indx:	Louisville, KY

Line #	Description					$11,911
	Manhours	Matl	Labor	Equipment	Sub	Total
1574220017	MGMNT, TECHN. & CLER. LABOR INCL PROJ INSP & VALID, DRAFT, ETC.				1.00 LOT	
Unit values	40.00	0.00	1000.00	0.00	0.00	1000.00
Totals	40.00	$0	$1,000	$0	$0	$1,000
1574220018	MISC TRAVEL EXPENSES				1.00 LOT	
Unit values	0.00	250.00	0.00	0.00	0.00	250.00
Totals	0.00	$250	$0	$0	$0	$250
U15 MECHANICAL	110	$4,949	$2,734	$0	$0	$7,687
ESTIMATE TOTAL	110	$4,949	$2,734	$0	$0	$7,687

Estimate:	20-30 POINTS	Date:	07 AUG 1995
Description:	TYPICAL FACILITY (UMCS-HVAC SYSTEMS POINTS)		
Project:	UMCS/SCADA	Bid Date:	
Location:	FT. CAMPBELL, KY	Job #:	SYSTEMS CORP #94013.08
Sq. footage:	1850.00	City indx:	Louisville, KY

Line #	Description					$11,911
	Manhours	Matl	Labor	Equipment	Sub	Total

SUMMARY

	Manhours	Matl	Labor	Equipment	Sub	Total
U15 MECHANICAL	110	$4,949	$2,734	$0	$0	$7,687
TOTAL	110	$4,949	$2,734	$0	$0	$7,687
SALES TAX	5.50%	$272				
MATL MARKUP	6.00%	$297				
LABOR MARKUP	15.00%		$410			
EQUIPT MARKUP	0.00%			$0		
SUB MARKUP	0.00%				$0	
TOTAL BEFORE CONTINGE		$5,518	$3,144	$0	$0	$8,662
CONTINGENCY	20.00%					$1,732
BOND	2.50%					$217
PROFIT	15.00%					$1,299
JOB TOTAL						$11,911

Estimate:	5-10 POINTS	Date:	07 AUG 1995
Description:	TYPICAL FACILITY (UMCS-HVAC SYSTEMS POINTS)		
Project:	UMCS/SCADA	Bid Date:	
Location:	FT. CAMPBELL, KY	Job #:	SYSTEMS CORP #94013.08
Sq. footage:	1850.00	City indx:	Louisville, KY

Line #	Description					$4,431
	Manhours	Matl	Labor	Equipment	Sub	Total
1574220001	DDC CONTROL MODULE : R 683					
					1.00 EA	
Unit values	4.00	500.00	100.00	0.00	0.00	600.00
Totals	4.00	$500	$100	$0	$0	$600
1574220002	RELAYS					
					2.00 EA	
Unit values	0.50	13.00	12.50	0.00	0.00	25.50
Totals	1.00	$26	$25	$0	$0	$51
1574220005	E/P TRANSDUCER					
					1.00 EA	
Unit values	1.00	135.00	25.00	0.00	0.00	160.00
Totals	1.00	$135	$25	$0	$0	$160
1574220006	WATER SENSORS W/WELL					
					2.00 EA	
Unit values	1.00	65.00	25.00	0.00	0.00	90.00
Totals	2.00	$130	$50	$0	$0	$180
1574220009	1/4" COPPER					
					100.00 L.F.	
Unit values	0.02	0.27	0.50	0.00	0.00	0.77
Totals	2.00	$27	$50	$0	$0	$77
1574220010	24" X 24" NEMA 12 ENCLOSURE					
					1.00 EA	
Unit values	4.00	100.00	100.00	0.00	0.00	200.00
Totals	4.00	$100	$100	$0	$0	$200
1574220012	18-2 WIRE					
					100.00 L.F.	
Unit values	0.01	0.10	0.25	0.00	0.00	0.35
Totals	1.00	$10	$25	$0	$0	$35

Estimate:	5-10 POINTS	Date:	07 AUG 1995
Description:	TYPICAL FACILITY (UMCS-HVAC SYSTEMS POINTS)		
Project:	UMCS/SCADA	Bid Date:	
Location:	FT. CAMPBELL, KY	Job #:	SYSTEMS CORP #94013.08
Sq. footage:	1850.00	City indx:	Louisville, KY

Line #	Description					$4,431
	Manhours	Matl	Labor	Equipment	Sub	Total
1574220014	MISC. ELECTRICAL					
	INCL. LIGHTNING PROTECTION, WIRE, TRAY				1.00 LOT	
Unit values	3.00	100.00	75.00	0.00	0.00	175.00
Totals	3.00	$100	$75	$0	$0	$175
1574220015	3/4" EMT C ONDUIT					
					100.00 L.F.	
Unit values	0.09	3.88	2.21	0.00	0.00	6.09
Totals	9.00	$388	$225	$0	$0	$613
1574220016	#14 THHN WIRING					
					300.00 L.F.	
Unit values	0.01	0.07	0.15	0.00	0.00	0.22
Totals	1.80	$20	$45	$0	$0	$65
1574220017	MGMNT, TECHN. & CLER. LABOR					
	INCL PROJ INSP & VALID, DRAFT, ETC.				1.00 LOT	
Unit values	20.00	0.00	500.00	0.00	0.00	500.00
Totals	20.00	$0	$500	$0	$0	$500
1574220018	MISC TRAVEL EXPENSES					
					1.00 LOT	
Unit values	0.00	200.00	0.00	0.00	0.00	200.00
Totals	0.00	$200	$0	$0	$0	$200
U15 MECHANICAL	49	$1,636	$1,216	$0	$0	$2,856
ESTIMATE TOTAL	49	$1,636	$1,216	$0	$0	$2,856

Estimate:	5-10 POINTS	Date:	07 AUG 1995
Description:	TYPICAL FACILITY (UMCS-HVAC SYSTEMS POINTS)		
Project:	UMCS/SCADA	Bid Date:	
Location:	FT. CAMPBELL, KY	Job #:	SYSTEMS CORP #94013.08
Sq. footage:	1850.00	City indx:	Louisville, KY

Line #	Description						$4,431
	Manhours	Matl	Labor	Equipment	Sub	Total	

SUMMARY

	Manhours	Matl	Labor	Equipment	Sub	Total
U15 MECHANICAL	49	$1,636	$1,216	$0	$0	$2,856
TOTAL	49	$1,636	$1,216	$0	$0	$2,856
SALES TAX	5.50%	$90				
MATL MARKUP	6.00%	$98				
LABOR MARKUP	15.00%		$182			
EQUIPT MARKUP	0.00%			$0		
SUB MARKUP	0.00%				$0	
TOTAL BEFORE CONTINGE		$1,824	$1,398	$0	$0	$3,223
CONTINGENCY	20.00%					$645
BOND	2.50%					$81
PROFIT	15.00%					$483
JOB TOTAL						$4,431

Estimate:	100 POINTS	Date:	07 AUG 1995
Description:	TYPICAL FACILITY (UMCS-HVAC SYSTEMS POINTS)		
Project:	UMCS/SCADA	Bid Date:	
Location:	FT. CAMPBELL, KY	Job #:	SYSTEMS CORP #94013.08
Sq. footage:	1850.00	City indx:	Louisville, KY

Line #	Description					$36,311
	Manhours	Matl	Labor	Equipment	Sub	Total
1574220001	DDC CONTROL MODULE : G 1010 P					
					2.00 EA	
Unit values	4.00	1850.00	100.00	0.00	0.00	1950.00
Totals	8.00	$3,700	$200	$0	$0	$3,900
1574220002	DDC CONTROL MODULE EXPANDER : X 4106 P					
					1.00 EA	
Unit values	4.00	1650.00	100.00	0.00	0.00	1750.00
Totals	4.00	$1,650	$100	$0	$0	$1,750
1574220003	DDC CONTROL MODULE EXPANDER : X 880					
					2.00 EA	
Unit values	3.00	685.00	75.00	0.00	0.00	760.00
Totals	6.00	$1,370	$150	$0	$0	$1,520
1574220004	DDC CONTROL MODULE : G 4106 P					
					3.00 EA	
Unit values	4.00	1750.00	100.00	0.00	0.00	1850.00
Totals	12.00	$5,250	$300	$0	$0	$5,550
1574220005	RM SENSORS					
					15.00 EA	
Unit values	1.00	24.00	25.00	0.00	0.00	49.00
Totals	15.00	$360	$375	$0	$0	$735
1574220006	DUCT SENSORS					
					16.00 EA	
Unit values	1.00	56.00	25.00	0.00	0.00	81.00
Totals	16.00	$896	$400	$0	$0	$1,296
1574220007	A 492 AVG KIT					
					10.00 EA	
Unit values	1.00	16.00	25.00	0.00	0.00	41.00
Totals	10.00	$160	$250	$0	$0	$410

Estimate:	100 POINTS	Date:	07 AUG 1995
Description:	TYPICAL FACILITY (UMCS-HVAC SYSTEMS POINTS)		
Project:	UMCS/SCADA	Bid Date:	
Location:	FT. CAMPBELL, KY	Job #:	SYSTEMS CORP #94013.08
Sq. footage:	1850.00	City indx:	Louisville, KY

Line #	Description					
						$36,311
	Manhours	Matl	Labor	Equipment	Sub	Total
1574220008	TRANSFORMER					
					2.00 EA	
Unit values	1.00	18.00	25.00	0.00	0.00	43.00
Totals	2.00	$36	$50	$0	$0	$86
1574220009	TERMINALS					
					120.00 EA	
Unit values	0.10	0.89	2.50	0.00	0.00	3.39
Totals	12.00	$106	$300	$0	$0	$406
1574220010	48X36 NEMA 12 ENCLOSURE					
					1.00 EA	
Unit values	8.00	295.00	200.00	0.00	0.00	495.00
Totals	8.00	$295	$200	$0	$0	$495
1574220011	CABLE TRAY					
					1.00 LOT	
Unit values	1.00	37.00	25.00	0.00	0.00	62.00
Totals	1.00	$37	$25	$0	$0	$62
1574220012	18-2 WIRE					
					2400.00 L.F.	
Unit values	0.01	0.09	0.25	0.00	0.00	0.34
Totals	23.04	$211	$600	$0	$0	$811
1574220013	1/4" COPPER & FITTING					
					1500.00 L.F.	
Unit values	0.02	0.27	0.50	0.00	0.00	0.77
Totals	30.00	$412	$750	$0	$0	$1,162
1574220014	MISC. ELECTRICAL INCL. LIGHTNING PROTECTION					
					1.00 LOT	
Unit values	8.00	150.00	200.00	0.00	0.00	350.00
Totals	8.00	$150	$200	$0	$0	$350

Estimate:	100 POINTS	Date:	07 AUG 1995
Description:	TYPICAL FACILITY (UMCS-HVAC SYSTEMS POINTS)		
Project:	UMCS/SCADA	Bid Date:	
Location:	FT. CAMPBELL, KY	Job #:	SYSTEMS CORP #94013.08
Sq. footage:	1850.00	City indx:	Louisville, KY

Line #	Description					$36,311
	Manhours	Matl	Labor	Equipment	Sub	Total
1574220015	3/4" EMT C ONDUIT					
					600.00 L.F.	
Unit values	0.09	1.67	2.21	0.00	0.00	3.88
Totals	53.04	$1,003	$1,326	$0	$0	$2,329
1574220016	#14 THHN WIRING					
					1800.00 L.F.	
Unit values	0.01	0.06	0.16	0.00	0.00	0.22
Totals	10.98	$113	$280	$0	$0	$393
1574220017	MGMNT, TECHN. & CLER. LABOR INCL PROJ INSP & VALID, DRAFT, ETC.				1.00 LOT	
Unit values	80.00	0.00	1800.00	0.00	0.00	1800.00
Totals	80.00	$0	$1,800	$0	$0	$1,800
1574220018	MISC TRAVEL EXPENSES					
					1.00 LOT	
Unit values	0.00	400.00	0.00	0.00	0.00	400.00
Totals	0.00	$400	$0	$0	$0	$400
U15 MECHANICAL	300	$16,149	$7,306	$0	$0	$23,455
ESTIMATE TOTAL	300	$16,149	$7,306	$0	$0	$23,455

Estimate:	100 POINTS	Date:	07 AUG 1995
Description:	TYPICAL FACILITY (UMCS-HVAC SYSTEMS POINTS)		
Project:	UMCS/SCADA	Bid Date:	
Location:	FT. CAMPBELL, KY	Job #:	SYSTEMS CORP #94013.08
Sq. footage:	1850.00	City indx:	Louisville, KY

Line #	Description					$36,311
	Manhours	Matl	Labor	Equipment	Sub	Total

SUMMARY

	Manhours	Matl	Labor	Equipment	Sub	Total
U15 MECHANICAL	300	$16,149	$7,306	$0	$0	$23,455
TOTAL	300	$16,149	$7,306	$0	$0	$23,455
SALES TAX	5.50%	$888				
MATL MARKUP	6.00%	$969				
LABOR MARKUP	15.00%		$1,096			
EQUIPT MARKUP	0.00%			$0		
SUB MARKUP	0.00%				$0	
TOTAL BEFORE CONTINGE		$18,006	$8,402	$0	$0	$26,408
CONTINGENCY	20.00%					$5,282
BOND	2.50%					$660
PROFIT	15.00%					$3,961
JOB TOTAL						$36,311

ECO 1
POINTS
LIST

ECO 1 POINTS LIST		
ECO Number	Building Type	Point Description
1A	Barracks	**Dual Temperature Pump Points -** on/off, status, return water temperature, supply water temperature, differential pressure
		Air Handling Units and Exhaust Fans - on/off, status
		Absorption Chiller Points - on/off, status, return water temperature, supply water temperature, steam pressure
1B	Administration	**Dual Temperature Pump Points -** on/off, status, return water temperature, supply water temperature, differential pressure
		Air-Cooled Chiller Points - on/off, status, return water temperature, supply water temperature, reset
		Multizone Air Handling Unit Points - on/off, status, hot deck supply air temperature, cold deck supply air temperature, mixed supply air temperature, zone space temperatures, zone dampers, outside air damper
1C	Hangars	**Single Zone Air Handling Unit Points -** on/off, status, space temperature, outside air damper
		Multizone Air Handling Unit Points - on/off, status, hot deck supply air temperature, cold deck supply air temperature, mixed air supply temperature, zone space temperature, zone damper, outside air damper
		Boiler Points - on/off, status, supply water temperature, return water temperature
		Dual Temperature Pump Points - on/off, status, return water temperature, supply water temperature, differential pressure
1D	Dining Facilities/Clubs	**Air Cooled Chiller Points -** on/off, status, return water temperature, supply water temperature, reset
		Single Zone Air Handling Unit Points - on/off, status, space temperature, outside air damper

ECO 1 POINTS LIST		
ECO Number	Building Type	Point Description
1D (Con't.)		**Multizone Air Handling Unit Points** - on/off, status, hot deck supply air temperature, cold deck supply air temperature, mixed air supply temperature, zone space temperature, zone damper, outside air damper
		Boiler Points - on/off, status, supply water temperature, return water temperature
		Dual temperature Pump Points - on/off, status, return water temperature, supply water temperature, differential pressure
		Exhaust Fans/Hoods - on/off, status
1E	Gyms/Recreation Facilities	**Single Zone Air Handling Unit Points** - on/off, status, space temperature, outside air damper
		Multizone Air Handling Unit Points - on/off, status, hot deck supply air temperature, cold deck supply air temperature, mixed air supply temperature, zone space temperature, zone damper, outside air damper
		Air Cooled Chiller Points - on/off, status, return water temperature, supply water temperature, reset
		Boiler Points - on/off, status, supply water temperature, return water temperature
		Dual Temperature Pump Points - on/off, status, return water temperature, supply water temperature, differential pressure
1F	Central Plants	**Chiller Points** - on/off, status, supply/return water temperature, reset #1, reset #2, reset #3, kW, condenser water supply/return temperatures
		Cooling Tower Fan Points - on/off, status

ECO 1 POINTS LIST		
ECO Number	Building Type	Point Description
1F (Con't.)		**Boiler Points** - on/off, status, steam pressure, steam temperature, steam flow, condensate temperature, condensate pump on/off and status, oil temperature, low water alarm, general alarm, stack temperature, stack O_2, stack CO_2, excess air, efficiency, feedwater temperature
		Chilled Water/Hot Water/Condenser Water Pump Points - on/off, status, supply/return water temperatures, differential pressure flow rate, head
		Air Compressors - on/off, status, air pressure
1G	Miscellaneous Buildings	**Air Cooled Chiller Points** - on/off, status, return water temperature, supply water temperature, reset
		Boiler Points - on/off, status, steam pressure, steam temperature, steam flow, condensate temperature, condensate pump on/off and status, oil temperature, low water alarm, general alarm, stack temperature, stack O_2, stack CO_2, excess air, efficiency, feedwater temperature
		Dual Temperature Pump Points - on/off, status, return water temperature, supply water temperature, differential pressure
		Single Zone Air Handling Unit Points - on/off, status, space temperature, outside air damper
		Multizone Air Handling Unit Points - on/off, status, hot deck supply air temperature, cold deck supply air temperature, mixed air supply temperature, zone space temperature, zone damper, outside air damper

ECO 2:
ELECTRICAL
SUBSTATIONS

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
STUDY: SCADA
LCCID FY95 (92)
INSTALLATION & LOCATION: FORT CAMPBELL REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: 94013.08 FEASIBILITY STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: ECO-2
ANALYSIS DATE: 10-20-95 ECONOMIC LIFE 10 YEARS PREPARED BY: KW

1. INVESTMENT
A. CONSTRUCTION COST $ 999104.
B. SIOH $ 49955.
C. DESIGN COST $ 49955.
D. TOTAL COST (1A+1B+1C) $ 1099014.
E. SALVAGE VALUE OF EXISTING EQUIPMENT $ 0.
F. PUBLIC UTILITY COMPANY REBATE $ 0.
G. TOTAL INVESTMENT (1D - 1E - 1F) $ 1099014.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 6.19	0.	$ 0.	8.58	$ 0.
B. DIST	$ 5.62	0.	$ 0.	9.62	$ 0.
C. RESID	$ .00	0.	$ 0.	10.53	$ 0.
D. NAT G	$ 4.35	0.	$ 0.	9.60	$ 0.
E. COAL	$ .00	0.	$ 0.	9.28	$ 0.
F. PPG	$ .00	0.	$ 0.	9.28	$ 0.
M. DEMAND SAVINGS			$ 0.	8.53	$ 0.
N. TOTAL		0.	$ 0.		$ 0.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 205000.
(1) DISCOUNT FACTOR (TABLE A) 8.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 1748650.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-) (4)
1. AVOIDANCE	$ 120000.	5	.86	103200.
d. TOTAL	$ 120000.			103200.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 1851850.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 217000.

5. SIMPLE PAYBACK PERIOD (1G/4) 5.06 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 1851850.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.69
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): N/A

*** MeansData Estimate ***

Estimate:	SUBSTATIONS	Date:	
Description:	MONITOR/CONTROL		
Project:	SCADA	Bid Date:	
Location:	FT CAMPBELL	Job #:	
Sq. footage:		City indx:	

Line #	Description					$999,104
	Manhours	Matl	Labor	Equipment	Sub	Total
0222580200	EXCAV UTIL TRNCH COMMON EARTH, CHAINTRNCHR 12HP OPERWLKG 4"W 24"DP				4000.00 L.F.	
Unit values	0.01	0.00	0.27	0.12	0.00	0.39
Totals	44.00	$0	$1,080	$480	$0	$1,560
0222581150	BKFIL UTILTRNCH BY HAND W/COMPCTN 4"WX24"D				4000.00 L.F.	
Unit values	0.02	0.00	0.38	0.15	0.00	0.53
Totals	80.00	$0	$1,520	$600	$0	$2,120
U02 SITEWORK	124	$0	$2,600	$1,080	$0	$3,680
1574223265	PARTIAL FRONT END COST SCADA SYSTEM				8.00 LOT	
Unit values	0.00	2260.00	0.00	0.00	0.00	2260.00
Totals	0.00	$18,080	$0	$0	$0	$18,080
U15 MECHANICAL	0	$18,080	$0	$0	$0	$18,080
1602055000	METALLIC TUBING, (EMT), 1/2" INCL. 2 TERM, 2 BENDS, 11 CLAMPS PER 100'				800.00 L.F.	
Unit values	0.05	0.38	1.29	0.00	0.00	1.67
Totals	37.60	$304	$1,032	$0	$0	$1,336
1602059100	CONDUIT, PVC, SCHEDULE 40, 1/2" DIAMETER				4000.00 L.F.	
Unit values	0.04	0.48	1.16	0.00	0.00	1.64
Totals	168.00	$1,920	$4,640	$0	$0	$6,560
1611552600	COMM/CONTROL CABLE				40.00 C.L.F.	
Unit values	1.51	52.00	41.50	0.00	0.00	93.50
Totals	60.36	$2,080	$1,660	$0	$0	$3,740
1688000010	CIRCUIT MONITOR, SQ. D - CM-2250					

	INSTRUMENTATION, ALARM/RELAY,WAVE FORM				9.00 EA		
Unit values	8.00	2930.00	228.00	0.00	0.00	3158.00
Totals	72.00	$26,370	$2,052	$0	$0	$28,422
1688000015	DIGITAL RELAY INSTRUMENTATION, ALARM/RELAY				23.00 EA	
Unit values	8.00	2190.00	228.00	0.00	0:00	2418.00
Totals	184.00	$50,370	$5,244	$0	$0	$55,614
1691504050	SUBSTATION EQUIPMENT INSTRUMENT TRANSF CURRENT TRANSF 13-26KV				92.00 Ea.	
Unit values	4.00	1500.00	100.00	41.50	0.00	1641.50
Totals	368.00	$138,000	$9,200	$3,818	$0	$151,018
1691504070	SUBSTATION EQUIPMENT INSTRUMENT TRANSF CURRENT TRANSF 69KV				36.00 Ea.	
Unit values	8.00	4500.00	201.00	83.00	0.00	4784.00
Totals	288.00	$162,000	$7,236	$2,988	$0	$172,224
1691504100	SUBSTATION EQUIPMENT INSTRUMENT POTENTIAL TRANSF 13-26KV				24.00 Ea.	
Unit values	5.00	2125.00	125.00	52.00	0.00	2302.00
Totals	120.00	$51,000	$3,000	$1,248	$0	$55,248
1691504120	SUBSTATION EQUIPMENT INSTRUMENT POTENTIAL TRANSF 69KV				27.00 Ea.	
Unit values	9.00	4625.00	226.00	93.50	0.00	4944.50
Totals	243.08	$124,875	$6,102	$2,525	$0	$133,502
1699000003	POWER LOGIC PRODUCT INTERFACE PIF 85				24.00 EA	
Unit values	2.50	1050.00	228.00	0.00	0.00	1278.00
Totals	60.00	$25,200	$5,472	$0	$0	$30,672
1699000004	TRANSFORMER TEMPERATURE CONTROL MODEL 85				24.00 EA	
Unit values	0.00	970.00	114.00	0.00	0.00	1084.00
Totals	0.00	$23,280	$2,736	$0	$0	$26,016
1699000050	THIRD PARTY INTERFACE MODULE				8.00 EA	
Unit values	8.00	2500.00	228.00	0.00	0.00	2728.00
Totals	64.00	$20,000	$1,824	$0	$0	$21,824
U16 ELECTRICAL	1666	$625,399	$50,198	$10,579	$0	$686,176
ESTIMATE TOTAL	1790	$643,479	$52,798	$11,659	$0	$707,936

SUMMARY

	Manhours	Matl	Labor	Equipment	Sub	Total
U02 SITEWORK	124	$0	$2,600	$1,080	$0	$3,680
U15 MECHANICAL	0	$18,080	$0	$0	$0	$18,080
U16 ELECTRICAL	1666	$625,399	$50,198	$10,579	$0	$686,176
TOTAL	1790	$643,479	$52,798	$11,659	$0	$707,936
SALES TAX	5.50%	$35,391				
MATL MARKUP	10.00%	$64,348				
LABOR MARKUP	15.00%		$7,920			
EQUIPT MARKUP	0.00%			$0		
SUB MARKUP	0.00%				$0	
TOTAL BEFORE CONTINGENCY		$743,218	$60,718	$11,659	$0	$815,595
CONTINGENCY	10.00%					$81,559
BOND	2.50%					$20,390
PROFIT	10.00%					$81,559
JOB TOTAL						$999,104

ECO 2

ELECTRICAL SUBSTATIONS CALCULATIONS

No energy or demand savings result from the UMCS/SCADA system's implementation.

Maintenance savings from UMCS/SCADA system are estimated to be five percent of equipment value including labor hours for repairs.

SAVINGS = $1,570,000 X .05 = $78,500/YR

Productivity man hours lost avoidance savings result from reducing the time required to restore power after an outage by one hour due to UMCS/SCADA's quick identification and isolation of the problems.

Estimated Calculation Factors:

- ⇨ at least two electrical failures occurred to a major portion of the electrical system
- ⇨ each failure takes 2-4 hours to restore
- ⇨ 25 percent of personnel are affected by a power outage

With 25 percent of personnel estimated to be affected by a power outage, the productivity lost avoidance savings is:

SAVINGS = 1 hr/outage x 0.25 x (21,500 active personnel + 3,900 civilian personnel) x $10/hr x 2 outages/yr. = $127,000/yr

Nonrecurring savings result from UMCS/SCADA system's implementation in that the electrical load study will not be required within the economic life of the project. Savings will equal $120,000.

ECO 3:
EMERGENCY GENERATORS

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
STUDY: SCADA
LCCID FY95 (92)
INSTALLATION & LOCATION: FORT CAMPBELL REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: 94013.08 FEASIBILITY STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: ECO-3
ANALYSIS DATE: 10-20-95 ECONOMIC LIFE 10 YEARS PREPARED BY: KW

1. INVESTMENT				
A. CONSTRUCTION COST	$ 381927.			
B. SIOH	$ 19096.			
C. DESIGN COST	$ 19096.			
D. TOTAL COST (1A+1B+1C)	$ 420119.			
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$	0.	
F. PUBLIC UTILITY COMPANY REBATE		$	0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)				$ 420119.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 6.19	0.	$ 0.	8.58	$ 0.
B. DIST	$ 5.62	-10332.	$ -58066.	9.62	$ -558593.
C. RESID	$ .00	0.	$ 0.	10.53	$ 0.
D. NAT G	$ 4.35	0.	$ 0.	9.60	$ 0.
E. COAL	$ .00	0.	$ 0.	9.28	$ 0.
F. PPG	$ .00	0.	$ 0.	9.28	$ 0.
M. DEMAND SAVINGS			$ 381672.	8.53	$ 3255662.
N. TOTAL		-10332.	$ 323606.		$ 2697069.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)		$ 74146.
(1) DISCOUNT FACTOR (TABLE A)	8.53	
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$ 632465.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 632465.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 397752.

5. SIMPLE PAYBACK PERIOD (1G/4) 1.06 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 3329534.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 7.93
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 26.69 %

*** MeansData Estimate ***

Estimate:	GENERATORS	Date:	
Description:	MONITOR/CONTROL		
Project:	SCADA	Bid Date:	
Location:	FT CAMPBELL	Job #:	
Sq. footage:		City indx:	

Line #	Description					$381,927
	Manhours	Matl	Labor	Equipment	Sub	Total
0222580200	EXCAV UTIL TRNCH COMMON EARTH, CHAINTRNCHR 12HP OPERWLKG 4"W 24"DP				11000.00 L.F.	
Unit values	0.01	0.00	0.27	0.12	0.00	0.39
Totals	121.00	$0	$2,970	$1,320	$0	$4,290
0222581150	BKFIL UTILTRNCH BY HAND W/COMPCTN 4"WX24"D				11000.00 L.F.	
Unit values	0.02	0.00	0.38	0.15	0.00	0.53
Totals	220.00	$0	$4,180	$1,650	$0	$5,830
U02 SITEWORK	341	$0	$7,150	$2,970	$0	$10,120
1574223265	PARTIAL FRONT END COST SCADA SYSTEM				44.00 LOT	
Unit values	0.00	2260.00	0.00	0.00	0.00	2260.00
Totals	0.00	$99,440	$0	$0	$0	$99,440
U15 MECHANICAL	0	$99,440	$0	$0	$0	$99,440
1602055000	METALLIC TUBING, (EMT), 1/2" INCL. 2 TERM, 2 BENDS, 11 CLAMPS PER 100'				1000.00 L.F.	
Unit values	0.05	0.38	1.29	0.00	0.00	1.67
Totals	47.00	$380	$1,290	$0	$0	$1,670
1602059100	CONDUIT, PVC, SCHEDULE 40, 1/2" DIAMETER				11000.00 L.F.	
Unit values	0.04	0.48	1.16	0.00	0.00	1.64
Totals	462.00	$5,280	$12,760	$0	$0	$18,040
1611552600	COMM/CONTROL CABLE				110.00 C.L.F.	
Unit values	1.51	52.00	41.50	0.00	0.00	93.50
Totals	165.99	$5,720	$4,565	$0	$0	$10,285
1688000015	CIRCUIT MONITOR, SQ. D CM-2150					

	INSTRUMENTATION, ALARM/RELAY				44.00 EA	
Unit values	8.00	2190.00	228.00	0.00	0.00	2418.00
Totals	352.00	$96,360	$10,032	$0	$0	$106,392
1699000050	THIRD PARTY INTERFACE MODULE					
					9.00 EA	
Unit values	8.00	2500.00	228.00	0.00	0.00	2728.00
Totals	72.00	$22,500	$2,052	$0	$0	$24,552
U16 ELECTRICAL	1099	$130,240	$30,699	$0	$0	$160,939
ESTIMATE TOTAL	1440	$229,680	$37,849	$2,970	$0	$270,499

SUMMARY

	Manhours	Matl	Labor	Equipment	Sub	Total
U02 SITEWORK	341	$0	$7,150	$2,970	$0	$10,120
U15 MECHANICAL	0	$99,440	$0	$0	$0	$99,440
U16 ELECTRICAL	1099	$130,240	$30,699	$0	$0	$160,939
TOTAL	1440	$229,680	$37,849	$2,970	$0	$270,499
SALES TAX	5.50%	$12,632				
MATL MARKUP	10.00%	$22,968				
LABOR MARKUP	15.00%		$5,677			
EQUIPT MARKUP	0.00%			$0		
SUB MARKUP	0.00%				$0	
TOTAL BEFORE CONTINGENCY		$265,280	$43,526	$2,970	$0	$311,777
CONTINGENCY	10.00%					$31,178
BOND	2.50%					$7,794
PROFIT	10.00%					$31,178
JOB TOTAL						$381,927

ECO 3

EMERGENCY GENERATORS, CALCULATIONS

- No energy savings result from UMCS/SCADA system's implementation
- Demand Saving

  Generators Utilized: 1-750 kW, 2-700 kW, 1-350 kW, 1-800 kW
  Total Capacity = 2,700 kW

$$\text{SAVINGS} = 2{,}700 \text{ kW} \times \frac{\$11.78}{\text{kW} \times \text{mo}} \times \frac{12\,\text{mo}}{\text{yr}}$$

SAVINGS = $381,672 per year

Fuel cost for demand management application:

FUEL COST/YR = GAL/HR X $/GAL X HR/YR					
Generator Capacity (kW)	Number of Units	Fuel Consumption Rate Gal/Hr	Fuel Cost $/Gal	Run Hour Per Year	Operation Cost per Year
FUEL COST/YR = GAL/HR X $/GAL X HR/YR					
Generator Capacity (kW)	Number of Units	Fuel Consumption Rate Gal/Hr	Fuel Cost $/Gal	Run Hour per Year	Operation Cost per Year
750	1	56	0.78	500	$21,840
700	2	52	0.78	500	$40,560
350	1	25	0.78	500	$9,750
200	1	16	0.78	500	$6,240
TOTAL ANNUAL FUEL COST					$78,390

Demand Savings = $381,672 - $78,390 = $303,282/Yr

➪ Maintenance Saving

Assumptions:

One failure prevented per year
Sixteen hours per generator saved in maintenance and repairs per year

Generator Value = $1,145,000 (44 units)
Equipment damage cost avoidance equals 5 percent of generator value

$$\text{Material Savings} = \frac{0.05}{\text{Generator Value per Year}} \times \$1{,}145{,}000 = \$57{,}250$$

$$\text{Labor Savings} = \frac{\$16\,\text{hr}}{\text{Generator per Year}} \times 44\ \text{Generators} \times \$24/\text{hr} = \$16{,}896/\text{yr}$$

Total Maintenance Savings = $57,250 + $16,896 = $74,146/yr

ECO 4:
WATER SYSTEM

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: SCADA
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)
INSTALLATION & LOCATION: FORT CAMPBELL REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: 94013.08 FEASIBILITY STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: ECO-4
ANALYSIS DATE: 10-20-95 ECONOMIC LIFE 10 YEARS PREPARED BY: KW

1. INVESTMENT
A. CONSTRUCTION COST $ 62700.
B. SIOH $ 3135.
C. DESIGN COST $ 3135.
D. TOTAL COST (1A+1B+1C) $ 68970.
E. SALVAGE VALUE OF EXISTING EQUIPMENT $ 0.
F. PUBLIC UTILITY COMPANY REBATE $ 0.
G. TOTAL INVESTMENT (1D - 1E - 1F) $ 68970.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 6.19	0.	$ 0.	8.58	$ 0.
B. DIST	$ 5.62	0.	$ 0.	9.62	$ 0.
C. RESID	$ .00	0.	$ 0.	10.53	$ 0.
D. NAT G	$ 4.35	0.	$ 0.	9.60	$ 0.
E. COAL	$ .00	0.	$ 0.	9.28	$ 0.
F. PPG	$ .00	0.	$ 0.	9.28	$ 0.
M. DEMAND SAVINGS			$ 55000.	8.53	$ 469150.
N. TOTAL		0.	$ 55000.		$ 469150.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 14600.
(1) DISCOUNT FACTOR (TABLE A) 8.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 124538.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-) (4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 124538.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 69600.

5. SIMPLE PAYBACK PERIOD (1G/4) .99 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 593688.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 8.61
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 27.74 %

Estimate:	Water treatment plant	Date:	Aug. 2,1995
Description:	SCADA System		
Project:	Ft. Campbell		
Location:		Job#	
Sq. footage:		City Index:	

Line#	Description						$56,841.00
		Manhours	Matl	Labor	Equiment	Sub	Total
	Control Module (8) DO, (10) inputs (G8102e)					3 ea	
Unit values			1600.00	169.00			1769.00
Totals			4800.00	507.00			5307.00
	Control module expander (8) DO (X800) (8) Universal inputs					1 ea	
Unit values			685.00	169.00			854.00
Totals			685.00	169.00			854.00
	Control Module cabinet					3 ea	
Unit values			165.00	84.50			249.50
Totals			495.00	253.50			748.50
	Control wiring Twisted pair					1000 LF	
Unit values			0.11	0.23			0.44
Totals			110.00	230.00			440.00
	Conduit					1000 LF	
Unit values			1.35	2.39			3.74
Totals			1350.00	2390.00			3740.00
	Water flow meter w/ transmitter					1 ea	
Unit values			3500.00				3500.00
Totals			3500.00				3500.00
	Water flow meter wet tap and weld-o-let					1 ea	
Unit values			565.00	42.00	5.25		612.25
Totals			565.00	42.00	5.25		612.25
	Pressure transmitter					1 ea	
Unit values			200.00				200.00
Totals			200.00				200.00
	Pressure transmitter wet tap and weld-o-let					1 ea	
Unit values			70.50	30.00			100.50
Totals			70.50	30.00			100.50
	300 HP variable speed drive					1 ea	
Unit values			40000.00	1125.00	214.00		41339.00
Totals			40000.00	1125.00	214.00		41339.00

ECO-4
WATER SYSTEM CALCULATIONS

Currently one 300 hp pump at the treatment plant, and one 300 hp pump at the Boiling Sprines Pumping Station operate during peak electrical demand:

$$DEMAND\ COST = 2 \times 300hp \times 0.745\frac{kW}{hp} \times \frac{\$11.78}{kW \times mo} \times 12\frac{mo}{yr} = \frac{\$63{,}188}{yr}$$

Proposed conditions will operate pumps at 50% flow during peak electrical demand. By pump similarity laws the power is proportional to the cube of the flow:

$$\left(\frac{105{,}000gpm}{210{,}000gpm}\right)^3 = \frac{X}{300} \qquad X = 37.5hp$$

$$NEW\ DEMAND\ COST = 2 \times 37.5 \times 0.745 \times \$11.78 \times 12 = \frac{\$7{,}898}{YR}$$

$$SAVINGS = 63{,}188 - 7898 = \$55{,}290$$

Operational savings result in one hour per day savings.

$$SAVINGS = \frac{\$40.00}{hr} \times 1\frac{hr}{day} \times 365\frac{days}{yr} = \$14{,}600$$

No non-recurring savings result from implementation of this ECO.

ECO 4

WATER SYSTEM CALCULATIONS

Currently one 300 hp pump at the treatment plant, and one 300 hp pump at the Boiling Springs Pumping Station operate during peak electrical demand:

$$\text{DEMAND COST} = 2 \times 300\text{hp} \times 0.745\frac{\text{kW}}{\text{hp}} \times \frac{\$11.78}{\text{kW} \times \text{mo}} \times 12\frac{\text{mo}}{\text{yr}} = \frac{\$63{,}188}{\text{yr}}$$

Proposed conditions will operate pumps at 50% flow during peak electrical demand. By pump affinity laws the power is proportional to the cube of the flow:

$$\left(\frac{105{,}000\text{ gpm}}{210{,}000\text{ gpm}}\right)^3 = \frac{X}{300} \qquad X = 37.5\text{hp}$$

$$\text{NEW DEMAND COST} = 2 \times 37.5 \times 0.745 \times \$11.78 \times 12 = \frac{\$7{,}898}{\text{yr}}$$

$$\text{SAVINGS} = 63{,}188 - 7898 = \$55{,}290$$

Operational savings result in one hour per day savings.

$$\text{SAVINGS} = \frac{\$40.00}{\text{hr}} \times 1\frac{\text{hr}}{\text{day}} \times 365\frac{\text{days}}{\text{yr}} = \$14{,}600$$

No non-recurring savings result from implementation of this ECO.

ECO 5:
SEWAGE WASTE SYSTEM

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT CAMPBELL REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: 94013.08 FEASIBILITY STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: ECO-5
ANALYSIS DATE: 10-20-95 ECONOMIC LIFE 10 YEARS PREPARED BY: KW

STUDY: SCADA
LCCID FY95 (92)

1. INVESTMENT

A. CONSTRUCTION COST	$ 205000.		
B. SIOH	$ 10250.		
C. DESIGN COST	$ 10250.		
D. TOTAL COST (1A+1B+1C)	$ 225500.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 225500.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 6.19	0.	$ 0.	8.58	$ 0.
B. DIST	$ 5.62	0.	$ 0.	9.62	$ 0.
C. RESID	$ .00	0.	$ 0.	10.53	$ 0.
D. NAT G	$ 4.35	0.	$ 0.	9.60	$ 0.
E. COAL	$ .00	0.	$ 0.	9.28	$ 0.
F. PPG	$ .00	0.	$ 0.	9.28	$ 0.
M. DEMAND SAVINGS			$ 0.	8.53	$ 0.
N. TOTAL		0.	$ 0.		$ 0.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 14600.
(1) DISCOUNT FACTOR (TABLE A) 8.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 124538.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 124538.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 14600.

5. SIMPLE PAYBACK PERIOD (1G/4) 15.45 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 124538.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= .55
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): N/A

Estimate:	Sewage lift stations	Date:	Aug. 2,1995
Description:	SCADA System		
Project:	Ft. Campbell		
Location:			Job#
Sq. footage:			City Index:

Line#	Description					$184,143.50
	Manhours	Matl	Labor	Equiment	Sub	Total
	Control modules (10) universal inputs (G0100)				35 ea	
Unit values		488.00	169.00			657.00
Totals		17080.00	5915.00			22995.00
	Control cabinet				35 ea	
Unit values		165.00	84.50			249.50
Totals		5775.00	2957.00			8732.50
	Control wiring, twisted pair				10500 LF	
Unit values		0.11	0.23			0.44
Totals		1155.00	2415.00			4620.00
	Conduit				3500 LF	
Unit values		1.35	2.39			3.74
Totals		4725.00	8365.00			13090.00
	By pass flow meter				35 ea	
Unit values		3500.00				3500.00
Totals		122500.00				122500.00
	By pass flow meter wet tap and weld-o-let				35 ea	
Unit values		315.00	30.00	3.76		348.76
Totals		11025.00	1050.00	131.60		12206.00

ECO-5
SEWAGE TREATMENT SYSTEM CALCUATIONS

No energy savings result from UMCS/SCADA system implementation.

Maintenance savings from UMCS/SCADA system implementation is approximately one hour per day savings:

$$SAVINGS = \frac{\$40.00}{hr} \times 1\frac{hr}{day} \times 365\frac{days}{yr}$$

$$SAVINGS = \frac{\$14,600}{yr}$$

No non-recurring savings result from implementation of this ECO.

ECO 5

SEWAGE TREATMENT SYSTEM CALCULATIONS

No energy savings result from UMCS/SCADA system implementation.

Maintenance savings from UMCS/SCADA system implementation is approximately one hour per day savings:

$$\text{SAVINGS} = \frac{\$40.00}{\text{hr}} \times 1\frac{\text{hr}}{\text{day}} \times 365\frac{\text{days}}{\text{yr}}$$

$$\text{SAVINGS} = \frac{\$14{,}600}{\text{yr}}$$

No non-recurring savings result from implementation of this ECO.

ECO 6:
REMOTE METERING

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: SCADA
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)
INSTALLATION & LOCATION: FORT CAMPBELL REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: 94013.08 FEASIBILITY STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: ECO-6
ANALYSIS DATE: 10-20-95 ECONOMIC LIFE 10 YEARS PREPARED BY: KW

1. INVESTMENT

A. CONSTRUCTION COST	$ 570922.		
B. SIOH	$ 28546.		
C. DESIGN COST	$ 28546.		
D. TOTAL COST (1A+1B+1C)	$ 628014.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 628014.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 6.19	0.	$ 0.	8.58	$ 0.
B. DIST	$ 5.62	0.	$ 0.	9.62	$ 0.
C. RESID	$ .00	0.	$ 0.	10.53	$ 0.
D. NAT G	$ 4.35	0.	$ 0.	9.60	$ 0.
E. COAL	$ .00	0.	$ 0.	9.28	$ 0.
F. PPG	$ .00	0.	$ 0.	9.28	$ 0.
M. DEMAND SAVINGS			$ 0.	8.53	$ 0.
N. TOTAL		0.	$ 0.		$ 0.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 24408.
(1) DISCOUNT FACTOR (TABLE A) 8.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 208200.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 208200.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 24408.

5. SIMPLE PAYBACK PERIOD (1G/4) 25.73 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 208200.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= .33
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): N/A

*** MeansData Estimate ***

Estimate:	METERING	Date:	
Description:	MONITOR/CONTROL		
Project:	SCADA	Bid Date:	
Location:	FT CAMPBELL	Job #:	
Sq. footage:		City indx:	

Line #	Description					$570,922
	Manhours	Matl	Labor	Equipment	Sub	Total
0222580200	EXCAV UTIL TRNCH COMMON EARTH, CHAINTRNCHR 12HP OPERWLKG 4"W 24"DP				7000.00 L.F.	
Unit values	0.01	0.00	0.27	0.12	0.00	0.39
Totals	77.00	$0	$1,890	$840	$0	$2,730
0222581150	BKFIL UTILTRNCH BY HAND W/COMPCTN 4"WX24"D				7000.00 L.F.	
Unit values	0.02	0.00	0.38	0.15	0.00	0.53
Totals	140.00	$0	$2,660	$1,050	$0	$3,710
U02 SITEWORK	217	$0	$4,550	$1,890	$0	$6,440
1574223265	PARTIAL FRONT END COST SCADA SYSTEM				65.00 LOT	
Unit values	0.00	2260.00	0.00	0.00	0.00	2260.00
Totals	0.00	$146,900	$0	$0	$0	$146,900
U15 MECHANICAL	0	$146,900	$0	$0	$0	$146,900
1602055000	METALLIC TUBING, (EMT), 1/2" INCL. 2 TERM, 2 BENDS, 11 CLAMPS PER 100'				800.00 L.F.	
Unit values	0.05	0.38	1.29	0.00	0.00	1.67
Totals	37.60	$304	$1,032	$0	$0	$1,336
1602059100	CONDUIT, PVC, SCHEDULE 40, 1/2" DIAMETER				7000.00 L.F.	
Unit values	0.04	0.48	1.16	0.00	0.00	1.64
Totals	294.00	$3,360	$8,120	$0	$0	$11,480
1611552600	COMM/CONTROL CABLE				70.00 C.L.F.	
Unit values	1.51	52.00	41.50	0.00	0.00	93.50
Totals	105.63	$3,640	$2,905	$0	$0	$6,545
1688000005	KW/KWH TRANSDUCERS					

					64.00 EA	
Unit values	1.00	500.00	28.50	0.00	0.00	528.50
Totals	64.00	$32,000	$1,824	$0	$0	$33,824
1688000007	GAS FLOW METER/TRANSDUCER					
					41.00 EA	
Unit values	0.00	4000.00	85.50	0.00	0.00	4085.50
Totals	0.00	$164,000	$3,506	$0	$0	$167,506
1699000075	AUTOMATED LOGIC G0100 MODULE				64.00 EA	
Unit values	1.00	438.75	27.48	0.00	0.00	466.23
Totals	64.00	$28,080	$1,759	$0	$0	$29,839
U16 ELECTRICAL	566	$231,384	$19,146	$0	$0	$250,530
ESTIMATE TOTAL	783	$378,284	$23,696	$1,890	$0	$403,870

SUMMARY

	Manhours	Matl	Labor	Equipment	Sub	Total
U02 SITEWORK	217	$0	$4,550	$1,890	$0	$6,440
U15 MECHANICAL	0	$146,900	$0	$0	$0	$146,900
U16 ELECTRICAL	566	$231,384	$19,146	$0	$0	$250,530
TOTAL	783	$378,284	$23,696	$1,890	$0	$403,870
SALES TAX	5.50%	$20,806				
MATL MARKUP	10.00%	$37,828				
LABOR MARKUP	15.00%		$3,554			
EQUIPT MARKUP	0.00%			$0		
SUB MARKUP	0.00%				$0	
TOTAL BEFORE CONTINGENCY		$436,918	$27,250	$1,890	$0	$466,058
CONTINGENCY	10.00%					$46,606
BOND	2.50%					$11,651
PROFIT	10.00%					$46,606
JOB TOTAL						$570,922

ECO 7: UNDERGROUND STORAGE TANK

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

STUDY: SCADA
LCCID FY95 (92)

INSTALLATION & LOCATION: FORT CAMPBELL REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: 94013.08 FEASIBILITY STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: ECO-7
ANALYSIS DATE: 10-20-95 ECONOMIC LIFE 10 YEARS PREPARED BY: KW

1. INVESTMENT

A. CONSTRUCTION COST	$ 27410.			
B. SIOH	$ 1371.			
C. DESIGN COST	$ 1371.			
D. TOTAL COST (1A+1B+1C)	$ 30152.			
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$	0.	
F. PUBLIC UTILITY COMPANY REBATE		$	0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)				$ 30152.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 6.19	0.	$ 0.	8.58	$ 0.
B. DIST	$ 5.62	0.	$ 0.	9.62	$ 0.
C. RESID	$ .00	0.	$ 0.	10.53	$ 0.
D. NAT G	$ 4.35	0.	$ 0.	9.60	$ 0.
E. COAL	$ .00	0.	$ 0.	9.28	$ 0.
F. PPG	$ .00	0.	$ 0.	9.28	$ 0.
M. DEMAND SAVINGS			$ 0.	8.53	$ 0.
N. TOTAL		0.	$ 0.		$ 0.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)		$ 1600.
(1) DISCOUNT FACTOR (TABLE A)	8.53	
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$ 13648.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
1. REPLACEMENT	$ 13700.	5	.86	11782.
2. SPILL	$ 5000.	5	.86	4300.
d. TOTAL	$ 18700.			16082.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 29730.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 3470.

5. SIMPLE PAYBACK PERIOD (1G/4) 8.69 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 29730.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= .99
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): N/A

*** MeansData Estimate ***

Estimate:	UNDERGROUND TANKS	Date:	
Description:	MONITOR		
Project:	SCADA	Bid Date:	
Location:	FT CAMPBELL	Job #:	
Sq. footage:		City indx:	

Line #	Description					$27,410
	Manhours	Matl	Labor	Equipment	Sub	Total
0222580200	EXCAV UTIL TRNCH COMMON EARTH, CHAINTRNCHR					
	12HP OPERWLKG 4"W 24"DP				2000.00 L.F.	
Unit values	0.01	0.00	0.27	0.12	0.00	0.39
Totals	22.00	$0	$540	$240	$0	$780
0222581150	BKFIL UTILTRNCH BY HAND W/COMPCTN 4"WX24"D					
					2000.00 L.F.	
Unit values	0.02	0.00	0.38	0.15	0.00	0.53
Totals	40.00	$0	$760	$300	$0	$1,060
U02 SITEWORK	62	$0	$1,300	$540	$0	$1,840
1574223265	PARTIAL FRONT END COST					
	SCADA SYSTEM				1.00 LOT	
Unit values	0.00	2260.00	0.00	0.00	0.00	2260.00
Totals	0.00	$2,260	$0	$0	$0	$2,260
U15 MECHANICAL	0	$2,260	$0	$0	$0	$2,260
1602059100	CONDUIT, PVC, SCHEDULE 40, 1/2" DIAMETER					
					2000.00 L.F.	
Unit values	0.04	0.48	1.16	0.00	0.00	1.64
Totals	84.00	$960	$2,320	$0	$0	$3,280
1611552600	COMM/CONTROL CABLE					
					20.00 C.L.F.	
Unit values	1.51	52.00	41.50	0.00	0.00	93.50
Totals	30.18	$1,040	$830	$0	$0	$1,870
1699000075	AUTOMATED LOGIC					
	G0100 MODULE				20.00 EA	
Unit values	1.00	438.75	27.48	0.00	0.00	466.23
Totals	20.00	$8,775	$550	$0	$0	$9,325
1699000080	AUTOMATED LOGIC					

X080 EXPANSION MODULE					3.00 EA	
Unit values	0.50	283.50	13.74	0.00	0.00	297.24
Totals	1.50	$851	$41	$0	$0	$892
U16 ELECTRICAL	136	$11,626	$3,741	$0	$0	$15,367
ESTIMATE TOTAL	198	$13,886	$5,041	$540	$0	$19,467

SUMMARY

	Manhours	Matl	Labor	Equipment	Sub	Total
U02 SITEWORK	62	$0	$1,300	$540	$0	$1,840
U15 MECHANICAL	0	$2,260	$0	$0	$0	$2,260
U16 ELECTRICAL	136	$11,626	$3,741	$0	$0	$15,367
TOTAL	198	$13,886	$5,041	$540	$0	$19,467
SALES TAX	5.50%	$764				
MATL MARKUP	10.00%	$1,389				
LABOR MARKUP	15.00%		$756			
EQUIPT MARKUP	0.00%			$0		
SUB MARKUP	0.00%				$0	
TOTAL BEFORE CONTINGE		$16,038	$5,797	$540	$0	$22,375
CONTINGENCY	10.00%					$2,238
BOND	2.50%					$559
PROFIT	10.00%					$2,238
JOB TOTAL						$27,410

ECO 8:
ATHLETIC FIELD
LIGHTS

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

STUDY: SCADA
LCCID FY95 (92)

INSTALLATION & LOCATION: FORT CAMPBELL REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: 94013.08 FEASIBILITY STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: ECO-8
ANALYSIS DATE: 10-20-95 ECONOMIC LIFE 10 YEARS PREPARED BY: KW

1. INVESTMENT

A. CONSTRUCTION COST	$ 47455.		
B. SIOH	$ 2373.		
C. DESIGN COST	$ 2373.		
D. TOTAL COST (1A+1B+1C)	$ 52201.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 52201.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 6.19	243.	$ 1504.	8.58	$ 12906.
B. DIST	$ 5.62	0.	$ 0.	9.62	$ 0.
C. RESID	$ .00	0.	$ 0.	10.53	$ 0.
D. NAT G	$ 4.35	0.	$ 0.	9.60	$ 0.
E. COAL	$ .00	0.	$ 0.	9.28	$ 0.
F. PPG	$ .00	0.	$ 0.	9.28	$ 0.
M. DEMAND SAVINGS			$ 54067.	8.53	$ 461192.
N. TOTAL		243.	$ 55571.		$ 474097.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 8.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 55571.

5. SIMPLE PAYBACK PERIOD (1G/4) .94 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 474097.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 9.08
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 28.43 %

*** MeansData Estimate ***

Estimate:	ATHELETIC FIELD LIGHTS	Date:	
Description:	MONITOR/CONTROL		
Project:	SCADA	Bid Date:	
Location:	FT CAMPBELL	Job #:	
Sq. footage:		City indx:	

Line #	Description					$47,455
	Manhours	Matl	Labor	Equipment	Sub	Total
0222580200	EXCAV UTIL TRNCH COMMON EARTH, CHAINTRNCHR 12HP OPERWLKG 4"W 24"DP				2000.00 L.F.	
Unit values	0.01	0.00	0.27	0.12	0.00	0.39
Totals	22.00	$0	$540	$240	$0	$780
0222581150	BKFIL UTILTRNCH BY HAND W/COMPCTN 4"WX24"D				2000.00 L.F.	
Unit values	0.02	0.00	0.38	0.15	0.00	0.53
Totals	40.00	$0	$760	$300	$0	$1,060
U02 SITEWORK	62	$0	$1,300	$540	$0	$1,840
1574223265	PARTIAL FRONT END COST SCADA SYSTEM				4.00 LOT	
Unit values	0.00	2260.00	0.00	0.00	0.00	2260.00
Totals	0.00	$9,040	$0	$0	$0	$9,040
U15 MECHANICAL	0	$9,040	$0	$0	$0	$9,040
1602055000	METALLIC TUBING, (EMT), 1/2" INCL. 2 TERM, 2 BENDS, 11 CLAMPS PER 100'				500.00 L.F.	
Unit values	0.05	0.38	1.29	0.00	0.00	1.67
Totals	23.50	$190	$645	$0	$0	$835
1602059100	CONDUIT, PVC, SCHEDULE 40, 1/2" DIAMETER				2000.00 L.F.	
Unit values	0.04	0.48	1.16	0.00	0.00	1.64
Totals	84.00	$960	$2,320	$0	$0	$3,280
1611552600	COMM/CONTROL CABLE				20.00 C.L.F.	
Unit values	1.51	52.00	41.50	0.00	0.00	93.50
Totals	30.18	$1,040	$830	$0	$0	$1,870

1611650960	WIRE 600V TYPE THWN-THHN, COPPER SOLID #10					
					10.00 C.L.F.	
Unit values	0.80	9.80	22.00	0.00	0.00	31.80
Totals	8.00	$98	$220	$0	$0	$318
1633100400	CONTACTOR LITING 600V 3 POLE 100AMP					
					4.00 Ea.	
Unit values	3.20	510.00	88.00	0.00	0.00	598.00
Totals	12.80	$2,040	$352	$0	$0	$2,392
1633200920	Control stations, NEMA 7 or 9, selector switch, 3 position					
					7.00 Ea.	
Unit values	2.00	230.00	57.00	0.00	0.00	287.00
Totals	14.00	$1,610	$399	$0	$0	$2,009
1661700400	Photoelectric control					
					7.00 Ea.	
Unit values	1.33	126.00	38.00	0.00	0.00	164.00
Totals	9.33	$882	$266	$0	$0	$1,148
1699000050	NETWORK INTERFACE MODULE					
					4.00 EA	
Unit values	8.00	2500.00	228.00	0.00	0.00	2728.00
Totals	32.00	$10,000	$912	$0	$0	$10,912
16 ELECTRICAL	214	$16,820	$5,944	$0	$0	$22,764
ESTIMATE TOTAL	276	$25,860	$7,244	$540	$0	$33,644

SUMMARY

	Manhours	Matl	Labor	Equipment	Sub	Total
U02 SITEWORK	62	$0	$1,300	$540	$0	$1,840
U15 MECHANICAL	0	$9,040	$0	$0	$0	$9,040
U16 ELECTRICAL	214	$16,820	$5,944	$0	$0	$22,764
TOTAL	276	$25,860	$7,244	$540	$0	$33,644
SALES TAX	5.50%	$1,422				
MATL MARKUP	10.00%	$2,586				
LABOR MARKUP	15.00%		$1,087			
EQUIPT MARKUP	0.00%			$0		
SUB MARKUP	0.00%				$0	
TOTAL BEFORE CONTINGE		$29,868	$8,331	$540	$0	$38,739
CONTINGENCY	10.00%					$3,874
BOND	2.50%					$968
PROFIT	10.00%					$3,874
JOB TOTAL						$47,455

ECO 9:
TRAFFIC SIGNALS

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: SCADA
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)
INSTALLATION & LOCATION: FORT CAMPBELL REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: 94013.08 FEASIBILITY STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: ECO-9
ANALYSIS DATE: 10-20-95 ECONOMIC LIFE 10 YEARS PREPARED BY: KW

1. INVESTMENT

A.	CONSTRUCTION COST	$ 140522.		
B.	SIOH	$ 7026.		
C.	DESIGN COST	$ 7026.		
D.	TOTAL COST (1A+1B+1C)	$ 154574.		
E.	SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F.	PUBLIC UTILITY COMPANY REBATE		$ 0.	
G.	TOTAL INVESTMENT (1D - 1E - 1F)			$ 154574.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 6.19	72.	$ 446.	8.58	$ 3824.
B. DIST	$ 5.62	0.	$ 0.	9.62	$ 0.
C. RESID	$ .00	0.	$ 0.	10.53	$ 0.
D. NAT G	$ 4.35	0.	$ 0.	9.60	$ 0.
E. COAL	$ .00	0.	$ 0.	9.28	$ 0.
F. PPG	$ .00	0.	$ 0.	9.28	$ 0.
M. DEMAND SAVINGS			$ 339.	8.53	$ 2892.
N. TOTAL		72.	$ 785.		$ 6716.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 984.
(1) DISCOUNT FACTOR (TABLE A) 8.53
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 8394.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 8394.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 1769.

5. SIMPLE PAYBACK PERIOD (1G/4) 87.40 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 15109.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= .10
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): N/A

*** MeansData Estimate ***

Estimate:	TRAFFIC LIGHTS	Date:	
Description:	MONITOR/CONTROL		
Project:	SCADA	Bid Date:	
Location:	FT CAMPBELL	Job #:	
Sq. footage:		City indx:	

Line #	Description					$140,522
	Manhours	Matl	Labor	Equipment	Sub	Total
0222580200	EXCAV UTIL TRNCH COMMON EARTH, CHAINTRNCHR 12HP OPERWLKG 4"W 24"DP				1500.00 L.F.	
Unit values	0.01	0.00	0.27	0.12	0.00	0.39
Totals	16.50	$0	$405	$180	$0	$585
0222581150	BKFIL UTILTRNCH BY HAND W/COMPCTN 4"WX24"D				1500.00 L.F.	
Unit values	0.02	0.00	0.38	0.15	0.00	0.53
Totals	30.00	$0	$570	$225	$0	$795
U02 SITEWORK	47	$0	$975	$405	$0	$1,380
1574223265	PARTIAL FRONT END COST SCADA SYSTEM				15.00 LOT	
Unit values	0.00	2260.00	0.00	0.00	0.00	2260.00
Totals	0.00	$33,900	$0	$0	$0	$33,900
U15 MECHANICAL	0	$33,900	$0	$0	$0	$33,900
1602055000	METALLIC TUBING, (EMT), 1/2" INCL. 2 TERM, 2 BENDS, 11 CLAMPS PER 100'				200.00 L.F.	
Unit values	0.05	0.38	1.29	0.00	0.00	1.67
Totals	9.40	$76	$258	$0	$0	$334
1602059100	CONDUIT, PVC, SCHEDULE 40, 1/2" DIAMETER				1500.00 L.F.	
Unit values	0.04	0.48	1.16	0.00	0.00	1.64
Totals	63.00	$720	$1,740	$0	$0	$2,460
1611552600	COMM/CONTROL CABLE				15.00 C.L.F.	
Unit values	1.51	52.00	41.50	0.00	0.00	93.50
Totals	22.64	$780	$623	$0	$0	$1,403

1661151100	LED TRAFFIC LIGHTS					
					60.00 Ea.	
Unit values	0.00	260.00	57.00	0.00	0.00	317.00
Totals	0.00	$15,600	$3,420	$0	$0	$19,020
1688000015	CIRCUIT MONITOR, SQ. D CM-2150					
	INSTRUMENTATION, ALARM/RELAY				0.00 EA	
Unit values	8.00	2190.00	228.00	0.00	0.00	2418.00
Totals	0.00	$0	$0	$0	$0	$0
1699000050	THIRD PARTY INTERFACE MODULE					
					15.00 EA	
Unit values	8.00	2500.00	228.00	0.00	0.00	2728.00
Totals	120.00	$37,500	$3,420	$0	$0	$40,920
U16 ELECTRICAL	216	$54,676	$9,461	$0	$0	$64,137
ESTIMATE TOTAL	263	$88,576	$10,436	$405	$0	$99,417

SUMMARY

	Manhours	Matl	Labor	Equipment	Sub	Total
U02 SITEWORK	47	$0	$975	$405	$0	$1,380
U15 MECHANICAL	0	$33,900	$0	$0	$0	$33,900
U16 ELECTRICAL	216	$54,676	$9,461	$0	$0	$64,137
TOTAL	263	$88,576	$10,436	$405	$0	$99,417
SALES TAX	5.50%	$4,872				
MATL MARKUP	10.00%	$8,858				
LABOR MARKUP	15.00%		$1,565			
EQUIPT MARKUP	0.00%			$0		
SUB MARKUP	0.00%				$0	
TOTAL BEFORE CONTINGENCY		$102,305	$12,001	$405	$0	$114,712
CONTINGENCY	10.00%					$11,471
BOND	2.50%					$2,868
PROFIT	10.00%					$11,471
JOB TOTAL						$140,522

ECO 9

TRAFFIC SIGNALS

No direct energy savings result from UMCS/SCADA system's implementation.

Related energy savings from replacing one incandescent red signal light to LED:

Replace 100-watt incandescent lamp with a 20-watt LED.
For 15 signal lights, a minimum of 30 red lamps will be on at a given time.

$$\text{Demand Savings} = 80\ \text{W/Lamp} \times \frac{1\ \text{kW}}{1{,}000\ \text{W}} \times 30\ \text{lamps} = 2.4\ \text{kW}$$

$$\text{Demand Dollar Savings} = 2.4\ \text{kW} \times FUN\$11.78/\text{kW} \times 12\ \text{Mo/Yr} = \$339.26$$

$$\text{Energy Savings} = 80\ \text{W/lamp} \times \frac{1\ \text{kW}}{1{,}000\ \text{W}} \times 8{,}760\ \text{hr/yr} \times 30\ \text{lamps} = 21{,}024\ \text{kWh/yr}$$

$$\text{Energy Dollars Savings} = 21{,}024\ \text{kWh/yr} \times \$0.0211/\text{kWh} = \$443.61/\text{yr}$$

Maintenance saving associated with red signal light lamp replacement over the economic life of the project (10 years):

INCANDESCENT		LED
Lamp Cost	$7.50/lamp	$260/lamp
Replacements required over 10 Years	10	0
Replacement Labor & Equipment Cost	$57/replacement	$57/replacement

Maintenance cost of incandescent over the project life = [$7.50/lamp x 30 lamps + $57/lamp x 30 lamps] x 10 years = $19,350

Maintenance cost of LEDs over the project life = [$260/lamp + $57/lamp] x 30 = $9,510

A savings of $9,840 over 10 years.

No non-recurring savings result from implementation of this ECO.

HVAC UNOCCUPIED OUTSIDE AIR REDUCTION

UNOCCUPIED OUTSIDE AIR REDUCTION
ADMINISTRATIVE BUILDINGS

Building	Area FT^2	Floors	Design Outside Air CFM	Savings - SUMMER MBTU/YR	Savings - SUMMER KWH/YR	Savings - WINTER MBTU/YR	Electric Savings $/YR	Natural Gas Savings $/YR
3672	25241	1	5,048	29.3	8,578.8	319.0	$56.74	$1,852.17
3680	15228	1	3,046	17.7	5,175.6	192.5	$34.23	$1,117.42
3686	15228	1	3,046	17.7	5,175.6	192.5	$34.23	$1,117.42
3755	15228	1	3,046	17.7	5,175.6	192.5	$34.23	$1,117.42
3759	15228	1	3,046	17.7	5,175.6	192.5	$34.23	$1,117.42
3763	11856	1	2,371	13.8	4,029.6	149.9	$26.65	$869.99
3767	20234	1	4,047	23.5	6,877.1	255.8	$45.48	$1,484.76
3780	9855	1	1,971	11.4	3,349.5	124.6	$22.15	$723.15
3962	9855	1	1,971	11.4	3,349.5	124.6	$22.15	$723.15
4013	5076	1	1,015	5.9	1,725.2	64.2	$11.41	$372.47
4017	5076	1	1,015	5.9	1,725.2	64.2	$11.41	$372.47
4021	5928	1	1,186	6.9	2,014.8	74.9	$13.33	$434.99
4025	6188	1	1,238	7.2	2,103.2	78.2	$13.91	$454.07
4029	20234	1	4,047	23.5	6,877.1	255.8	$45.48	$1,484.76
4054	25241	1	5,048	29.3	8,578.8	319.0	$56.74	$1,852.17
4062	15228	1	3,046	17.7	5,175.6	192.5	$34.23	$1,117.42
4068	15228	1	3,046	17.7	5,175.6	192.5	$34.23	$1,117.42
5661	22480	1	4,496	26.1	7,640.4	284.1	$50.53	$1,649.57
5740	14173	2	2,835	16.4	4,817.1	179.1	$31.86	$1,040.01
6254	9338	3	1,868	10.8	3,173.8	118.0	$20.99	$685.22
6390	12792	1	2,558	14.8	4,347.7	161.7	$28.75	$938.67
6709	38145	3	7,629	44.2	12,964.6	482.2		$3,222.90
6710	38406	3	7,681	44.6	13,053.3	485.5		$3,244.95
6711	38329	3	7,666	44.5	13,027.1	484.5		$3,238.45
6712	38285	3	7,657	44.4	13,012.2	483.9		$3,234.73
6715	18902	2	3,780	21.9	6,424.4	238.9		$1,597.05
6718	31869	2	6,374	37.0	10,831.5	402.8		$2,692.64
6719	31779	2	6,356	36.9	10,800.9	401.7		$2,685.03
6728	38285	3	7,657	44.4	13,012.2	483.9		$3,234.73
6901	9303	3	1,861	10.8	3,161.9	117.6		$786.02
6909	31758	3	6,352	36.8	10,793.8	401.4		$2,683.26
6910	38089	3	7,618	44.2	12,945.6	481.4		$3,218.17
6911	38208	3	7,642	44.3	12,986.0	482.9		$3,228.23
6914	3610	1	722	4.2	1,227.0	45.6		$305.01
6917	38480	3	7,696	44.6	13,078.5	486.4		$3,251.21

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UNOCCUPIED OUTSIDE AIR REDUCTION
BARRACKS

Building	Area FT^2	Floors	Design Outside Air CFM	Savings - SUMMER MBTU/YR	Savings - SUMMER KWH/YR	Savings - WINTER MBTU/YR	Electric Savings $/YR	Natural Gas Savings $/YR
3211	39,722	3	7,944	56.4	16,526.6	104.1		$1,144.47
3212	39,772	3	7,954	56.5	16,547.4	104.2		$1,145.91
3213	42,627	3	8,525	60.5	17,735.2	111.7		$1,228.16
3214	42,627	3	8,525	60.5	17,735.2	111.7		$1,228.16
3215	39,809	3	7,962	56.5	16,562.8	104.3		$1,146.97
3216	39,809	3	7,962	56.5	16,562.8	104.3		$1,146.97
3217	39,722	3	7,944	56.4	16,526.6	104.1		$1,144.47
3218	39,722	3	7,944	56.4	16,526.6	104.1		$1,144.47
3713	44,156	3	8,831	62.7	18,371.4	115.7	$121.51	$671.61
3725	44,156	3	8,831	62.7	18,371.4	115.7	$121.51	$671.61
3730	33,104	3	6,621	47.0	13,773.1	86.7	$91.09	$503.51
3731	33,275	3	6,655	47.3	13,844.3	87.2	$91.56	$506.11
3748	33,104	3	6,621	47.0	13,773.1	86.7	$91.09	$503.51
3750	33,104	3	6,621	47.0	13,773.1	86.7	$91.09	$503.51
3754	33,284	3	6,657	47.3	13,848.0	87.2	$91.59	$506.25
3766	44,106	3	8,821	62.6	18,350.6	115.6	$121.37	$670.85
4024	33,104	3	6,621	47.0	13,773.1	86.7	$91.09	$503.51
4028	33,104	3	6,621	47.0	13,773.1	86.7	$91.09	$503.51
4033	33,104	3	6,621	47.0	13,773.1	86.7	$91.09	$503.51
4038	44,156	3	8,831	62.7	18,371.4	115.7	$121.51	$671.61
4039	33,104	3	6,621	47.0	13,773.1	86.7	$91.09	$503.51
4044	33,104	3	6,621	47.0	13,773.1	86.7	$91.09	$503.51
4053	22,053	3	4,411	31.3	9,175.3	57.8	$60.68	$335.43
4057	33,104	3	6,621	47.0	13,773.1	86.7	$91.09	$503.51
4067	44,106	3	8,821	62.6	18,350.6	115.6	$121.37	$670.85
6725	38,241	3	7,648	54.3		100.2		$1,101.79
6726	38,160	3	7,632	54.2		100.0		$1,099.46
6727	38,312	3	7,662	54.4		100.4		$1,103.84
6730	38,138	3	7,628	54.2		99.9		$1,098.83
6731	38,208	3	7,642	54.3		100.1		$1,100.84
6732	38,442	3	7,688	54.6		100.7		$1,107.59
6733	37,977	3	7,595	53.9		99.5		$1,094.19
6774	31,953	3	6,391	45.4		83.7		$920.63
6775	38,137	3	7,627	54.2		99.9		$1,098.80
6776	38,152	3	7,630	54.2		100.0		$1,099.23
6777	38,249	3	7,650	54.3		100.2		$1,102.03
6778	38,180	3	7,636	54.2		100.0		$1,100.04
6779	39,722	3	7,944	56.4		104.1		$1,144.47
6780	39,722	3	7,944	56.4		104.1		$1,144.47
6781	37,904	3	7,581	53.8		99.3		$1,092.09
6782	38,131	3	7,626	54.1		99.9		$1,098.63
6783	31,737	3	6,347	45.1		83.2		$914.40
6912	38,310	3	7,662	54.4		100.4		$1,103.78
6918	38,646	3	7,729	54.9		101.3		$1,113.46
6919	38,711	3	7,742	55.0		101.4		$1,115.34
6920	38,649	3	7,730	54.9		101.3		$1,113.55
6921	38,465	3	7,693	54.6		100.8		$1,108.25

UNOCCUPIED OUTSIDE AIR REDUCTION
BARRACKS

Building	Area FT^2	Floors	Design Outside Air CFM	Savings - SUMMER MBTU/YR	Savings - SUMMER KWH/YR	Savings - WINTER MBTU/YR	Electric Savings $/YR	Natural Gas Savings $/YR
6922	38,691	3	7,738	54.9		101.4		$1,114.76
6923	38,465	3	7,693	54.6		100.8		$1,108.25
6927	38,118	3	7,624	54.1		99.9		$1,098.25
6928	38,120	3	7,624	54.1		99.9		$1,098.31
6929	38,281	3	7,656	54.4		100.3		$1,102.95
6930	38,196	3	7,639	54.2		100.1		$1,100.50
6931	31,713	3	6,343	45.0		83.1		$913.71
6936	31,735	3	6,347	45.1		83.1		$914.34
6937	37,900	3	7,580	53.8		99.3		$1,091.97
6938	38,039	3	7,608	54.0		99.7		$1,095.97
6939	38,137	3	7,627	54.2		99.9		$1,098.80
6940	38,127	3	7,625	54.1		99.9		$1,098.51
6942	38,098	3	7,620	54.1		99.8		$1,097.67
6943	38,049	3	7,610	54.0		99.7		$1,096.26
6944	38,063	3	7,613	54.0		99.7		$1,096.67
6945	31,685	3	6,337	45.0		83.0		$912.90
7110	23,628	3	4,726	33.6	9,830.6	61.9	$65.02	$359.38
7112	25,625	3	5,125	36.4	10,661.4	67.1	$70.51	$389.76
7118	25,625	3	5,125	36.4	10,661.4	67.1	$70.51	$389.76
7120	25,625	3	5,125	36.4	10,661.4	67.1	$70.51	$389.76

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UNOCCUPIED OUTSIDE AIR REDUCTION
HANGARS

Building	Area FT^2	Floors	Design Outside Air CFM	Savings - SUMMER MBTU/YR	Savings - SUMMER KWH/YR	Savings - WINTER MBTU/YR	Electric Savings $/YR	Natural Gas Savings $/YR
6628	63,697	1	3,185	18.5	5,412.3	201.3	$45.56	$1,168.51
7206	24,178	1	1,209	7.0	2,054.4	76.4	$17.29	$443.54
7208	38,792	1	1,940	11.2	3,296.1	122.6	$27.75	$711.63
7210	32,611	1	1,631	9.5	2,770.9	103.1	$23.32	$598.24
7214	41,860	1	2,093	12.1	3,556.8	132.3	$29.94	$767.92
7218	41,860	1	2,093	12.1	3,556.8	132.3	$29.94	$767.92
7245	49,139	1	2,457	14.3	4,175.3	155.3	$35.15	$901.45
7249	49,369	1	2,468	14.3	4,194.8	156.0	$35.31	$905.67
7251	41,117	1	2,056	11.9	3,493.7	129.9	$29.41	$754.29
7264	60,000	1	3,000	17.4	5,098.2	189.6	$42.91	$1,100.69

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UNOCCUPIED OUTSIDE AIR REDUCTION
DINING FACILITIES / CLUBS

Building	Area FT^2	Floors	Design Outside Air CFM	Savings - SUMMER MBTU/YR	Savings - SUMMER KWH/YR	Savings - WINTER MBTU/YR	Electric Savings $/YR	Natural Gas Savings $/YR
2577	42470	1	8494	14.8	4330.4	294.6	$28.64	$1,710.09
3717	13895	1	2779	4.8	1416.8	96.4	$9.37	$559.49
3721	6673	1	1335	2.3	680.4	46.3	$4.50	$268.69
3910	16264	1	3253	5.7	1658.3	112.8	$10.97	$654.88
4061	16150	1	3230	5.6	1646.7	112.0	$10.89	$650.29

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UNOCCUPIED OUTSIDE AIR REDUCTION

RECREATION CENTERS / GYMS

Building	Area FT^2	Floors	Design Outside Air CFM	Savings - SUMMER MBTU/YR	Savings - SUMMER KWH/YR	Savings - WINTER MBTU/YR	Electric Savings $/YR	Natural Gas Savings $/YR
2270	18,124	1	3,625	5.3	1,540.0	104.8	$10.19	$608.15
3411	20,918	1	4,184	6.1	1,777.4	120.9	$11.76	$701.90
3610	20,618	3	4,124	6.0	1,751.9	119.2	$11.59	$691.83
3932	20,618	1	4,124	6.0	1,751.9	119.2	$11.59	$691.83
6145	23,450	1	4,690	6.8	1,992.5	135.5	$13.18	$786.86
6990	20,618	1	4,124	6.0	1,751.9	119.2	$11.59	$691.83
6992	20,618	1	4,124	6.0	1,751.9	119.2	$11.59	$691.83
7540	11,574	1	2,315	3.4	983.4	66.9	$6.50	$388.36

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UNOCCUPIED OUTSIDE AIR REDUCTION
MISCELLANEOUS BUILDINGS

Building	Area FT^2	Floors	Design Outside Air CFM	Savings - SUMMER		Savings - WINTER MBTU/YR	Electric Savings $/YR	Natural Gas Savings $/YR
				MBTU/YR	KWH/YR			
38	16,038	1	3,208	14.0	4,088.2	152.0	$27.04	$882.64
89.	11,545	1	2,309	10.0	2,942.9	109.4	$19.46	$635.37
91	12,873	1	2,575	11.2	3,281.4	122.0	$21.70	$708.46
93	17,497	2	3,499	15.2	4,460.1	165.9	$29.50	$962.94
96	6,059	1	1,212	5.3	1,544.5	57.4	$10.21	$333.45
98	102,645	1	20,529	89.3	26,165.0	973.1	$173.05	$5,649.02
2702	104,978	1	20,996	91.3	26,759.7	995.2	$176.98	$5,777.42
3202	13,381	1	2,676	11.6	3,410.9	126.9	$22.56	$736.42
3603	14,606	1	2,921	12.7	3,723.2	138.5	$24.62	$803.83
3958	5,786	1	1,157	5.0	1,474.9	54.9	$9.75	$318.43
5207	169,375	1	33,875	147.4	43,175.0	1605.7	$285.55	$9,321.48
5580.	14,606	1	2,921	12.7	3,723.2	138.5	$24.62	$803.83
5663	12,204	1	2,441	10.6	3,110.9	115.7	$20.57	$671.64
5702	13,381	1	2,676	11.6	3,410.9	126.9	$22.56	$736.42
5875	10,040	1	2,008	8.7	2,559.3	95.2	$16.93	$552.55
5980	12,133	1	2,427	10.6	3,092.8	115.0	$20.46	$667.73
6551	16,758	1	3,352					
6721	7,714	1	1,543	6.7	1,966.4	73.1	$13.01	$424.54

UNOCCUPIED OUTSIDE AIR REDUCTION
HANGARS

Building	Area FT^2	Floors	Design Outside Air CFM	Savings - SUMMER MBTU/YR	Savings - SUMMER KWH/YR	Savings - WINTER MBTU/YR	Electric Savings $/YR	Natural Gas Savings $/YR
6628	63,697	1	3,185	9.2	2,706.1	184.1	$22.78	$1,068.67
7206	24,178	1	1,209	3.5	1,027.2	69.9	$8.65	$405.64
7208	38,792	1	1,940	5.6	1,648.1	112.1	$13.87	$650.83
7210	32,611	1	1,631	4.7	1,385.5	94.2	$11.66	$547.13
7214	41,860	1	2,093	6.1	1,778.4	121.0	$14.97	$702.30
7218	41,860	1	2,093	6.1	1,778.4	121.0	$14.97	$702.30
7245	49,139	1	2,457	7.1	2,087.7	142.0	$17.57	$824.43
7249	49,369	1	2,468	7.2	2,097.4	142.7	$17.66	$828.28
7251	41,117	1	2,056	6.0	1,746.8	118.8	$14.70	$689.84
7264	60,000	1	3,000	8.7	2,549.1	173.4	$21.46	$1,006.64

UNOCCUPIED OUTSIDE AIR REDUCTION
DINING FACILITIES / CLUBS

Building	Area FT^2	Floors	Design Outside Air CFM	Savings - SUMMER MBTU/YR	Savings - SUMMER KWH/YR	Savings - WINTER MBTU/YR	Electric Savings $/YR	Natural Gas Savings $/YR
2577	42470	1	8494	14.8	4330.4	294.6	$28.64	$1,710.09
3717	13895	1	2779	4.8	1416.8	96.4	$9.37	$559.49
3721	6673	1	1335	2.3	680.4	46.3	$4.50	$268.69
3910	16264	1	3253	5.7	1658.3	112.8	$10.97	$654.88
4061	16150	1	3230	5.6	1646.7	112.0	$10.89	$650.29

UNOCCUPIED OUTSIDE AIR REDUCTION
RECREATION CENTERS / GYMS

Building	Area FT^2	Floors	Design Outside Air CFM	Savings - SUMMER MBTU/YR	Savings - SUMMER KWH/YR	Savings - WINTER MBTU/YR	Electric Savings $/YR	Natural Gas Savings $/YR
2270	18,124	1	3,625	5.3	1,540.0	104.8	$10.19	$608.15
3411	20,918	1	4,184	6.1	1,777.4	120.9	$11.76	$701.90
3610	20,618	3	4,124	6.0	1,751.9	119.2	$11.59	$691.83
3932	20,618	1	4,124	6.0	1,751.9	119.2	$11.59	$691.83
6145	23,450	1	4,690	6.8	1,992.5	135.5	$13.18	$786.86
6990	20,618	1	4,124	6.0	1,751.9	119.2	$11.59	$691.83
6992	20,618	1	4,124	6.0	1,751.9	119.2	$11.59	$691.83
7540	11,574	1	2,315	3.4	983.4	66.9	$6.50	$388.36

HVAC UNOCCUPIED TEMPERATURE SETBACK

UNOCCUPIED TEMPERATURE SETBACK

ADMINISTRATIVE BUILDINGS

Building	Area	Floors	Wall - U	Roof - U	Roof Area	Wall Area	Savings - SUMMER		Savings - WINTER	Electric Savings	Natural Gas Savings
	FT^2		BTU/H*FT^2*F	BTU/H*FT^2*F	FT^2	FT^2	MBTU/YR	KWH/YR	MBTU/YR	$/YR	$/YR
3672	25,241	1	0.226	0.162	25,241	6,355	39.8	11,656.0	166.1	$77.09	$964.04
3680	15,228	1	0.226	0.162	15,228	4,936	25.8	7,557.5	107.7	$49.98	$625.07
3686	15,228	1	0.226	0.162	15,228	4,936	25.8	7,557.5	107.7	$49.98	$625.07
3755	15,228	1	0.226	0.162	15,228	4,936	25.8	7,557.5	107.7	$49.98	$625.07
3759	15,228	1	0.226	0.162	15,228	4,936	25.8	7,557.5	107.7	$49.98	$625.07
3763	11,856	1	0.226	0.162	11,856	4,355	20.9	6,128.3	87.3	$40.53	$506.86
3767	20,234	1	0.226	0.162	20,234	5,690	32.9	9,627.7	137.2	$63.68	$796.29
3780	9,855	1	0.226	0.162	9,855	3,971	18.0	5,261.2	75.0	$34.80	$435.14
3962	9,855	1	0.226	0.162	9,855	3,971	18.0	5,261.2	75.0	$34.80	$435.14
4013	5,076	1	0.226	0.162	5,076	2,850	10.6	3,093.4	44.1	$20.46	$255.85
4017	5,076	1	0.226	0.162	5,076	2,850	10.6	3,093.4	44.1	$20.46	$255.85
4021	5,928	1	0.226	0.162	5,928	3,080	11.9	3,494.2	49.8	$23.11	$289.00
4025	6,188	1	0.226	0.162	6,188	3,147	12.3	3,614.9	51.5	$23.91	$298.98
4029	20,234	1	0.226	0.162	20,234	5,690	32.9	9,627.7	137.2	$63.68	$796.29
4054	25,241	1	0.226	0.162	25,241	6,355	39.8	11,656.0	166.1	$77.09	$964.04
4062	15,228	1	0.226	0.162	15,228	4,936	25.8	7,557.5	107.7	$49.98	$625.07
4068	15,228	1	0.226	0.162	15,228	4,936	25.8	7,557.5	107.7	$49.98	$625.07
5661	22,480	1	0.226	0.162	22,480	5,997	36.0	10,541.9	150.2	$69.72	$871.90
5740	14,173	2	0.226	0.162	14,173	9,524	32.0	9,384.4	133.7	$62.07	$776.16
6254	9,338	3	0.226	0.162	9,338	11,596	29.8	8,719.9	124.2	$57.67	$721.20
6390	12,792	1	0.226	0.162	12,792	4,524	22.3	6,528.6	93.0	$43.18	$539.97
6709	38,145	3	0.226	0.162	38,145	23,437	82.6	24,210.0	344.9		$2,558.28
6710	38,406	3	0.226	0.162	38,406	23,517	83.1	24,337.4	346.7		$2,571.74
6711	38,329	3	0.226	0.162	38,329	23,493	82.9	24,299.8	346.2		$2,567.77
6712	38,285	3	0.226	0.162	38,285	23,480	82.9	24,278.4	345.9		$2,565.50
6715	18,902	2	0.226	0.162	18,902	10,999	39.9	11,703.6	166.7		$1,236.72
6718	31,869	2	0.226	0.162	31,869	14,282	60.4	17,700.2	252.2		$1,870.39
6719	31,779	2	0.226	0.162	31,779	14,261	60.3	17,659.8	251.6		$1,866.12
6728	38,285	3	0.226	0.162	38,285	23,480	82.9	24,278.4	345.9		$2,565.50
6901	9,303	3	0.226	0.162	9,303	11,574	29.7	8,697.5	123.9		$919.07
6909	31,758	3	0.226	0.162	31,758	21,385	71.8	21,049.0	299.9		$2,224.25
6910	38,089	3	0.226	0.162	38,089	23,420	82.5	24,182.7	344.5		$2,555.39
6911	38,208	3	0.226	0.162	38,208	23,456	82.7	24,240.8	345.4		$2,561.53
6914	3,610	1	0.226	0.162	3,610	2,403	8.1	2,379.6	33.9		$251.45
6917	38,480	3	0.226	0.162	38,480	23,540	83.2	24,373.5	347.2		$2,575.55

UNOCCUPIED TEMPERATURE SETBACK

BARRACKS

Building	Area	Floors	Wall - U	Roof - U	Roof Area	Wall Area	Savings - SUMMER		Savings - WINTER	Electric Savings	Natural Gas Savings
	FT^2		BTU/H*FT^2*F	BTU/H*FT^2*F	FT^2	FT^2	MBTU/YR	KWH/YR	MBTU/YR	$/YR	$/YR
3,211	39,722	3	0.226	0.162	39,722	23,916	72.0	21,092.2	95.5		$1,178.99
3,212	39,772	3	0.226	0.162	39,772	23,932	72.1	21,112.7	95.6		$1,180.14
3,213	42,627	3	0.226	0.162	42,627	24,776	76.0	22,276.4	100.9		$1,245.19
3,214	42,627	3	0.226	0.162	42,627	24,776	76.0	22,276.4	100.9		$1,245.19
3,215	39,809	3	0.226	0.162	39,809	23,943	72.1	21,127.9	95.7		$1,180.99
3,216	39,809	3	0.226	0.162	39,809	23,943	72.1	21,127.9	95.7		$1,180.99
3,217	39,722	3	0.226	0.162	39,722	23,916	72.0	21,092.2	95.5		$1,178.99
3,218	39,722	3	0.226	0.162	39,722	23,916	72.0	21,092.2	95.5		$1,178.99
3,713	44,156	3	0.226	0.162	44,156	25,216	78.1	22,895.0	103.7	$151.42	$602.11
3,725	44,156	3	0.226	0.162	44,156	25,216	78.1	22,895.0	103.7	$151.42	$602.11
3,730	33,104	3	0.226	0.162	33,104	21,833	62.6	18,343.7	83.1	$121.32	$482.41
3,731	33,275	3	0.226	0.162	33,275	21,890	62.9	18,415.7	83.4	$121.80	$484.31
3,748	33,104	3	0.226	0.162	33,104	21,833	62.6	18,343.7	83.1	$121.32	$482.41
3,750	33,104	3	0.226	0.162	33,104	21,833	62.6	18,343.7	83.1	$121.32	$482.41
3,754	33,284	3	0.226	0.162	33,284	21,893	62.9	18,419.5	83.4	$121.82	$484.41
3,766	44,106	3	0.226	0.162	44,106	25,202	78.1	22,874.8	103.6	$151.29	$601.58
4,024	33,104	3	0.226	0.162	33,104	21,833	62.6	18,343.7	83.1	$121.32	$482.41
4,028	33,104	3	0.226	0.162	33,104	21,833	62.6	18,343.7	83.1	$121.32	$482.41
4,033	33,104	3	0.226	0.162	33,104	21,833	62.6	18,343.7	83.1	$121.32	$482.41
4,038	44,156	3	0.226	0.162	44,156	25,216	78.1	22,895.0	103.7	$151.42	$602.11
4,039	33,104	3	0.226	0.162	33,104	21,833	62.6	18,343.7	83.1	$121.32	$482.41
4,044	33,104	3	0.226	0.162	33,104	21,833	62.6	18,343.7	83.1	$121.32	$482.41
4,053	22,053	3	0.226	0.162	22,053	17,820	46.2	13,538.8	61.3	$89.54	$356.05
4,057	33,104	3	0.226	0.162	33,104	21,833	62.6	18,343.7	83.1	$121.32	$482.41
4,067	44,106	3	0.226	0.162	44,106	25,202	78.1	22,874.8	103.6	$151.29	$601.58
6,725	38,241	3	0.226	0.162	38,241	23,466	69.9		92.8		$1,144.97
6,726	38,160	3	0.226	0.162	38,160	23,442	69.8		92.6		$1,143.11
6,727	38,312	3	0.226	0.162	38,312	23,488	70.0		92.9		$1,146.61
6,730	38,138	3	0.226	0.162	38,138	23,435	69.8		92.6		$1,142.60

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UNOCCUPIED TEMPERATURE SETBACK

BARRACKS

Building	Area	Floors	Wall - U	Roof - U	Roof Area	Wall Area	Savings - SUMMER		Savings - WINTER	Electric Savings	Natural Gas Savings
	FT^2		BTU/H*FT^2*F	BTU/H*FT^2*F	FT^2	FT^2	MBTU/YR	KWH/YR	MBTU/YR	$/YR	$/YR
6,731	38,208	3	0.226	0.162	38,208	23,456	69.9		92.7		$1,144.21
6,732	38,442	3	0.226	0.162	38,442	23,528	70.2		93.2		$1,149.60
6,733	37,977	3	0.226	0.162	37,977	23,385	69.5		92.3		$1,138.89
6,774	31,953	3	0.226	0.162	31,953	21,450	60.9		80.9		$998.17
6,775	38,137	3	0.226	0.162	38,137	23,434	69.8		92.6		$1,142.58
6,776	38,152	3	0.226	0.162	38,152	23,439	69.8		92.6		$1,142.92
6,777	38,249	3	0.226	0.162	38,249	23,469	69.9		92.8		$1,145.16
6,778	38,180	3	0.226	0.162	38,180	23,448	69.8		92.7		$1,143.57
6,779	39,722	3	0.226	0.162	39,722	23,916	72.0		95.5		$1,178.99
6,780	39,722	3	0.226	0.162	39,722	23,916	72.0		95.5		$1,178.99
6,781	37,904	3	0.226	0.162	37,904	23,363	69.4		92.2		$1,137.21
6,782	38,131	3	0.226	0.162	38,131	23,433	69.8		92.6		$1,142.44
6,783	31,737	3	0.226	0.162	31,737	21,378	60.6		80.5		$993.06
6,912	38,310	3	0.226	0.162	38,310	23,488	70.0		92.9		$1,146.56
6,918	38,646	3	0.226	0.162	38,646	23,590	70.5		93.5		$1,154.30
6,919	38,711	3	0.226	0.162	38,711	23,610	70.6		93.7		$1,155.79
6,920	38,649	3	0.226	0.162	38,649	23,591	70.5		93.6		$1,154.37
6,921	38,465	3	0.226	0.162	38,465	23,535	70.2		93.2		$1,150.13
6,922	38,691	3	0.226	0.162	38,691	23,604	70.5		93.6		$1,155.33
6,923	38,465	3	0.226	0.162	38,465	23,535	70.2		93.2		$1,150.13
6,927	38,118	3	0.226	0.162	38,118	23,429	69.7		92.6		$1,142.14
6,928	38,120	3	0.226	0.162	38,120	23,429	69.7		92.6		$1,142.19
6,929	38,281	3	0.226	0.162	38,281	23,479	70.0		92.9		$1,145.90
6,930	38,196	3	0.226	0.162	38,196	23,453	69.8		92.7		$1,143.94
6,931	31,713	3	0.226	0.162	31,713	21,370	60.6		80.4		$992.49
6,936	31,735	3	0.226	0.162	31,735	21,377	60.6		80.5		$993.01
6,937	37,900	3	0.226	0.162	37,900	23,362	69.4		92.2		$1,137.11
6,938	38,039	3	0.226	0.162	38,039	23,404	69.6		92.4		$1,140.32
6,939	38,137	3	0.226	0.162	38,137	23,434	69.8		92.6		$1,142.58

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UNOCCUPIED TEMPERATURE SETBACK

BARRACKS

Building	Area FT^2	Floors	Wall - U BTU/H*FT^2*F	Roof - U BTU/H*FT^2*F	Roof Area FT^2	Wall Area FT^2	Savings - SUMMER		Savings - WINTER MBTU/YR	Electric Savings $/YR	Natural Gas Savings $/YR
							MBTU/YR	KWH/YR			
6,940	38,127	3	0.226	0.162	38,127	23,431	69.8		92.6		$1,142.35
6,942	38,098	3	0.226	0.162	38,098	23,422	69.7		92.5		$1,141.68
6,943	38,049	3	0.226	0.162	38,049	23,407	69.6		92.4		$1,140.55
6,944	38,063	3	0.226	0.162	38,063	23,412	69.7		92.5		$1,140.87
6,945	31,685	3	0.226	0.162	31,685	21,360	60.6		80.4		$991.82
7,110	23,628	3	0.226	0.162	23,628	18,446	48.6	14,245.1	64.5	$94.21	$374.63
7,112	25,625	3	0.226	0.162	25,625	19,209	51.6	15,128.9	68.5	$100.06	$397.87
7,118	25,625	3	0.226	0.162	25,625	19,209	51.6	15,128.9	68.5	$100.06	$397.87
7,120	25,625	3	0.226	0.162	25,625	19,209	51.6	15,128.9	68.5	$100.06	$397.87

UNOCCUPIED TEMPERATURE SETBACK

HANGARS

Building	Area FT^2	Floors	Wall - U BTU/H*FT^2*F	Roof - U BTU/H*FT^2*F	Roof Area FT^2	Wall Area FT^2	Savings - SUMMER		Savings - WINTER MBTU/YR	Electric Savings $/YR	Natural Gas Savings $/YR
							MBTU/YR	KWH/YR			
6,628	63,697	1	0.226	0.162	63,697	10,095	22.7	6,645.4	378.7	$55.94	$2,198.52
7,206	24,178	1	0.226	0.162	24,178	6,220	9.6	2,807.1	160.0	$23.63	$928.66
7,208	38,792	1	0.226	0.162	38,792	7,878	14.5	4,253.3	242.4	$35.80	$1,407.14
7,210	32,611	1	0.226	0.162	32,611	7,223	12.4	3,647.2	207.8	$30.70	$1,206.61
7,214	41,860	1	0.226	0.162	41,860	8,184	15.5	4,551.9	259.4	$38.32	$1,505.91
7,218	41,860	1	0.226	0.162	41,860	8,184	15.5	4,551.9	259.4	$38.32	$1,505.91
7,245	49,139	1	0.226	0.162	49,139	8,867	17.9	5,255.2	299.5	$44.24	$1,738.59
7,249	49,369	1	0.226	0.162	49,369	8,888	18.0	5,277.3	300.7	$44.42	$1,745.91
7,251	41,117	1	0.226	0.162	41,117	8,111	15.3	4,479.7	255.3	$37.71	$1,482.03
7,264	60,000	1	0.226	0.162	60,000	9,798	21.5	6,294.1	358.7	$52.98	$2,082.29

UNOCCUPIED TEMPERATURE SETBACK

DINING FACILITIES / CLUBS

Building	Area	Floors	Wall - U	Roof - U	Roof Area	Wall Area	Savings - SUMMER		Savings - WINTER	Electric Savings	Natural Gas Savings
	FT^2		BTU/H*FT^2*F	BTU/H*FT^2*F	FT^2	FT^2	MBTU/YR	KWH/YR	MBTU/YR	$/YR	$/YR
1,501	32,643	1	0.226	0.162	32,643	7,227	19.8	5,798.0	111.4	$38.35	$646.72
2,577	42,470	1	0.226	0.162	42,470	8,243	25.0	7,323.9	140.7	$48.44	$816.93
3,717	13,895	1	0.226	0.162	13,895	4,715	9.5	2,778.2	53.4	$18.37	$309.89
3,721	6,673	1	0.226	0.162	6,673	3,268	5.2	1,524.1	29.3	$10.08	$170.01
3,910	16,264	1	0.226	0.162	16,264	5,101	10.8	3,172.8	61.0	$20.98	$353.91
4,061	16,150	1	0.226	0.162	16,150	5,083	10.8	3,154.0	60.6	$20.86	$351.80

UNOCCUPIED TEMPERATURE SETBACK
RECREATION BUILDINGS / GYMS

Building	Area	Floors	Wall - U	Roof - U	Roof Area	Wall Area	Savings - SUMMER		Savings - WINTER	Electric Savings	Natural Gas Savings
	FT^2		BTU/H*FT^2*F	BTU/H*FT^2*F	FT^2	FT^2	MBTU/YR	KWH/YR	MBTU/YR	$/YR	$/YR
2,270	18,124	1	0.226	0.162	18,124	5,385			55.7		$323.38
3,411	20,918	1	0.226	0.162	20,918	5,785			63.0		$365.66
3,610	20,618	3	0.226	0.162	20,618	17,231			97.0		$563.29
3,932	20,618	1	0.226	0.162	20,618	5,744			62.2		$361.15
6,145	23,450	1	0.226	0.162	23,450	6,125			69.5		$403.59
6,990	20,618	1	0.226	0.162	20,618	5,744			62.2		$361.15
6,992	20,618	1	0.226	0.162	20,618	5,744			62.2		$361.15
7,540	11,574	1	0.226	0.162	11,574	4,303			38.2		$221.72

UNOCCUPIED TEMPERATURE SETBACK
MISCELLANEOUS BUILDINGS

Building	Area	Floors	Wall - U	Roof - U	Roof Area	Wall Area	Savings - SUMMER		Savings - WINTER	Electric Savings	Natural Gas Savings
	FT^2		BTU/H*FT^2*F	BTU/H*FT^2*F	FT^2	FT^2	MBTU/YR	KWH/YR	MBTU/YR	$/YR	$/YR
38	16,038	1	0.226	0.162	16,038	5,066	13.4	3,919.3	84.4	$25.92	$489.81
89	11,545	1	0.226	0.162	11,545	4,298	10.2	2,975.5	64.1	$19.68	$371.85
91	12,873	1	0.226	0.162	12,873	4,538	14.8	4,343.5	70.1	$28.73	$407.12
93	17,497	2	0.226	0.162	17,497	10,582	57.0	16,686.5	117.8	$110.36	$683.88
96	6,059	1	0.226	0.162	6,059	3,114	4.0	1,176.4	38.0	$7.78	$220.53
98	102,645	1	0.226	0.162	102,645	12,815	46.5	13,629.6	440.1	$90.14	$2,555.00
2,702	104,978	1	0.226	0.162	104,978	12,960	47.5	13,916.2	449.4	$92.04	$2,608.74
3,202	13,381	1	0.226	0.162	13,381	4,627	15.3	4,486.4	72.4	$29.67	$420.51
3,603	14,606	1	0.226	0.162	14,606	4,834	16.5	4,828.8	78.0	$31.94	$452.60
3,958	5,786	1	0.226	0.162	5,786	3,043	3.9	1,134.3	36.6	$7.50	$212.64
5,207	169,375	1	0.226	0.162	169,375	16,462	148.5	43,502.3	702.4	$287.72	$4,077.47
5,580	14,606	1	0.226	0.162	14,606	4,834	16.5	4,828.8	78.0	$31.94	$452.60
5,663	12,204	1	0.226	0.162	12,204	4,419	7.1	2,077.2	67.1	$13.74	$389.40
5,702	13,381	1	0.226	0.162	13,381	4,627	15.3	4,486.4	72.4	$29.67	$420.51
5,875	10,040	1	0.226	0.162	10,040	4,008	9.0	2,651.6	57.1	$17.54	$331.37
5,980	12,133	1	0.226	0.162	12,133	4,406	14.1	4,134.4	66.8	$27.34	$387.51
6,551	16,758	1	0.226	0.162	16,758	5,178					
6,721	7,714	1	0.226	0.162	7,714	3,513	7.3	2,139.9	46.1	$14.15	$267.43

The peak cooling load is 110 tons.

On weekends, when simulators are not in use, the average cooling load is approximately 55 tons. Simulators are unused 17 weekends per year. The chillers operate at 1.1 kW/ton; so,

$$(55 \text{ Tons})\left(1.1 \frac{\text{kW}}{\text{Ton}}\right) = 60.5 \text{ kW}$$

$$(60.5 \text{ kW})\left(17 \frac{\text{Wks}}{\text{Yr}}\right)\left(48 \frac{\text{Hrs}}{\text{Wk}}\right) = 49{,}368 \frac{\text{kW Hr}}{\text{Yr}}$$

Electrical cost is \$0.02114/kW · Hr; so,

$$\text{Cost Savings} = (\$0.02114/\text{kW Hr})\left(49{,}368 \frac{\text{kW Hr}}{\text{Yr}}\right)$$

Cost Savings = \$1,040/Yr for each simulator building.

APPENDIX D: PRODUCT DATA

APPENDIX D

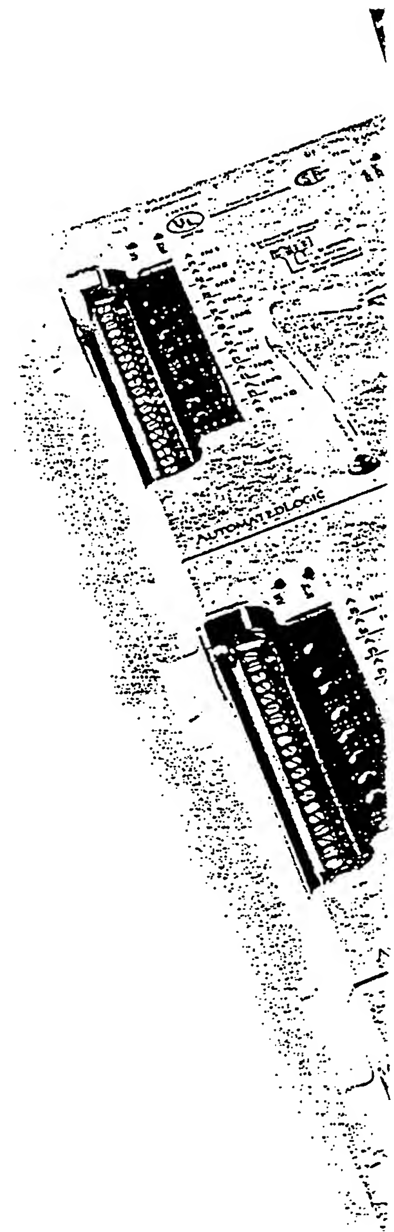
PRODUCT DATA

NETWORK AND BUILDING CONTROL PRODUCTS

Power and Simplicity: The Winning Combination

The Automated Logic® family of I/O hardware is based on a highly modular design with four lines, each targeted for a particular set of applications. These four lines include:

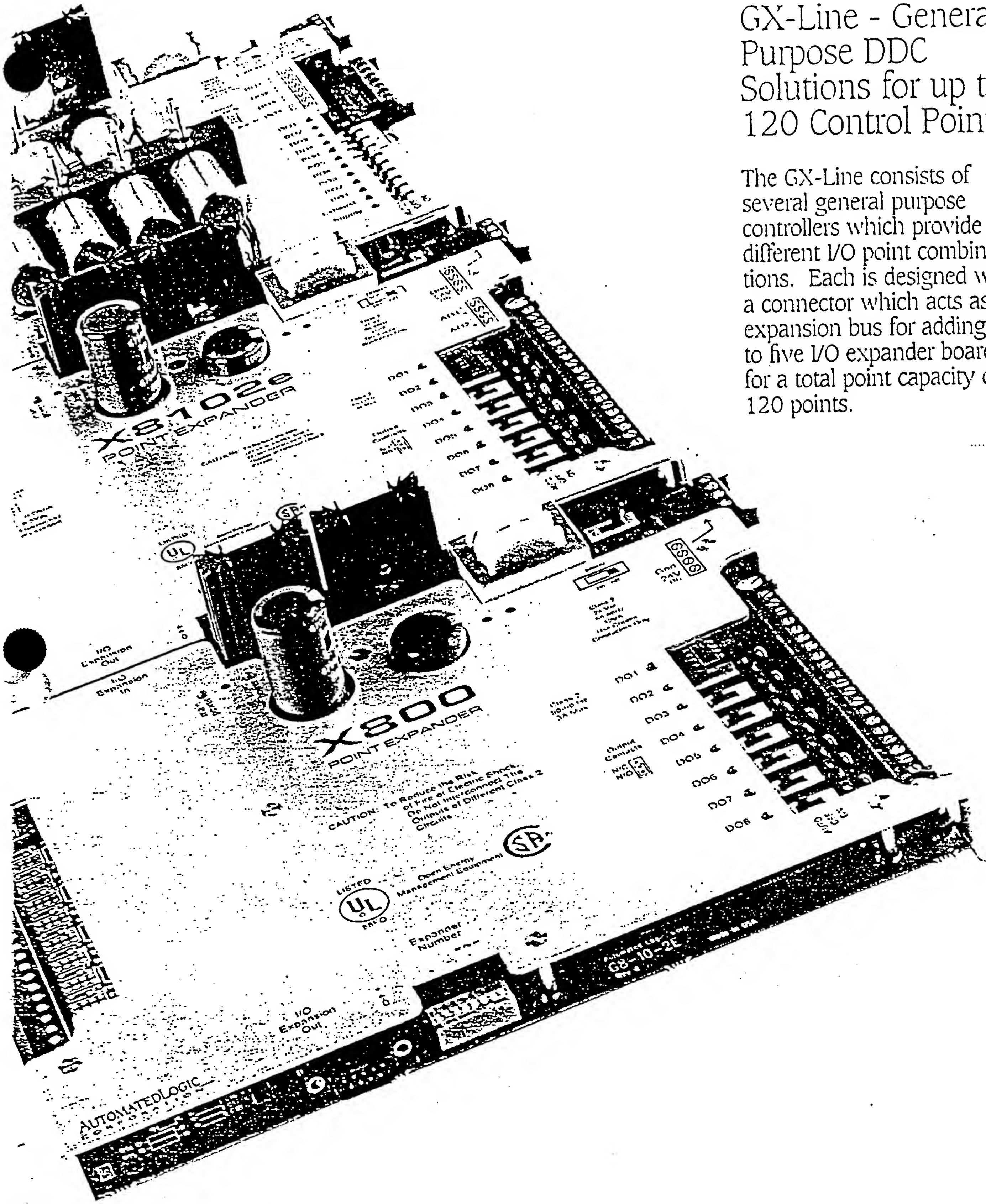
- The **GX-Line**, for General purpose DDC control with eXpandibility for up to 120 control points.
- The **R-Line**, for built-up Roof-top unit control.
- The **Z-Line**, for single Zone control.
- The **T-Line**, for a low-cost solution for large scale Terminal unit control.



All Automated Logic I/O hardware is engineered using the EIKON® graphic programming system and all operating and performance information is presented through the SuperVision® graphic operator interface.

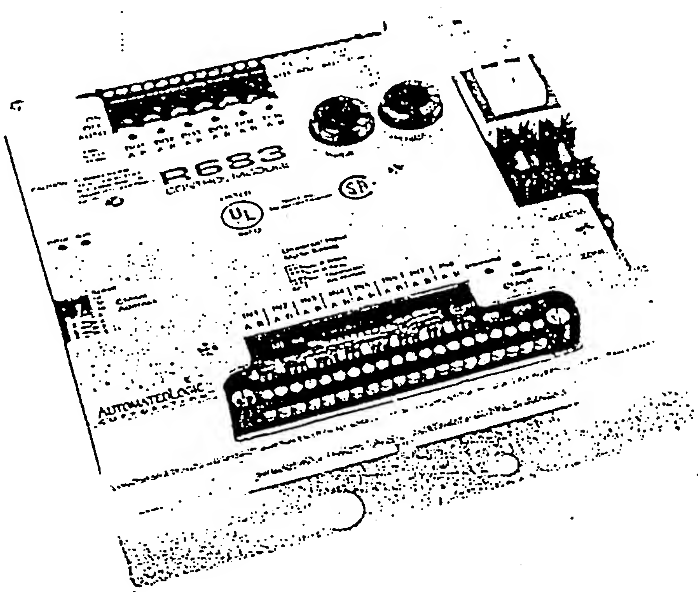
The simplicity of this modular, target-application design puts the power of control in the hands of specifying engineers to develop cost-effective solutions for their clients ... at the fingertips of facilities operators to easily monitor and maintain their building systems ... and in the long-range facilities plans of owners to effectively manage the expansion of their building control systems as tenant needs warrant.

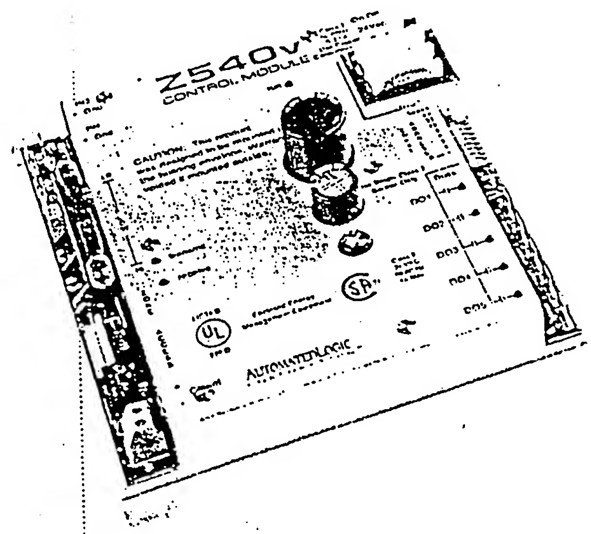
Let's take a closer look at each of these control application solutions ...



GX-Line - General Purpose DDC Solutions for up to 120 Control Points

The GX-Line consists of several general purpose controllers which provide different I/O point combinations. Each is designed with a connector which acts as an expansion bus for adding up to five I/O expander boards, for a total point capacity of 120 points.



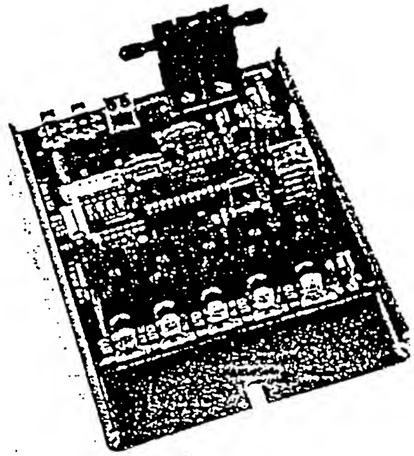


R-Line - For Roof-top Air Handling Unit Control

Uniquely designed for control of roof-top air handling units, R-Line controllers may be mounted directly in or on the roof-top equipment. R-Line controllers feature an I/O configuration of 6 digital outputs, 8 universal inputs and 3 analog outputs.

Z-Line - For Single Zone Control

Designed to provide zone control for fan coil units, heat pumps, unit ventilators, and terminal boxes, the Z-Line features two models: one with 2 inputs, 3 outputs and a flow sensor; and one model with 4 inputs and 5 outputs, which is available with or without a flow sensor. Z-Line controllers are designed to be mounted directly on the equipment being controlled.



T-Line - For Specific Function Zone Control

The T-Line of zone controllers was developed to provide an affordable solution for applications which require the same function for a large number of terminal units. The line features two models: one with 2 inputs and 3 outputs, and one with 4 inputs and 5 outputs. Both are available with or without a flow sensor. Each T-Line controller is programmed for a single control function.

Reliability Runs in the Family

All Automated Logic® controllers communicate with one another with equal authority on a peer-to-peer basis to share global information necessary to implement building-wide strategies. Each controller, however, contains the intelligence necessary to operate in a standalone mode should network communications be lost, thereby ensuring minimal disruption to environmental or mechanical conditions.

Each controller provides the power circuitry, the microprocessor, and non-volatile memory. Controllers feature an aluminum cover designed to withstand adverse mechanical and electrical conditions. This cover design also provides better electrical protection and noise immunity than traditional housing materials by acting as a ground plane which surrounds all vital circuitry. All Automated Logic I/O hardware is UL listed.

The Automated Logic line of building control solutions is represented by a network of authorized dealers. This highly trained team of DDC control engineers and technicians has installed Automated Logic equipment in thousands of facilities worldwide. All Automated Logic software and hardware is developed and manufactured at the company's headquarters under a system of Total Quality Management.

I/O HardWare

STANDALONE CONTROLLERS

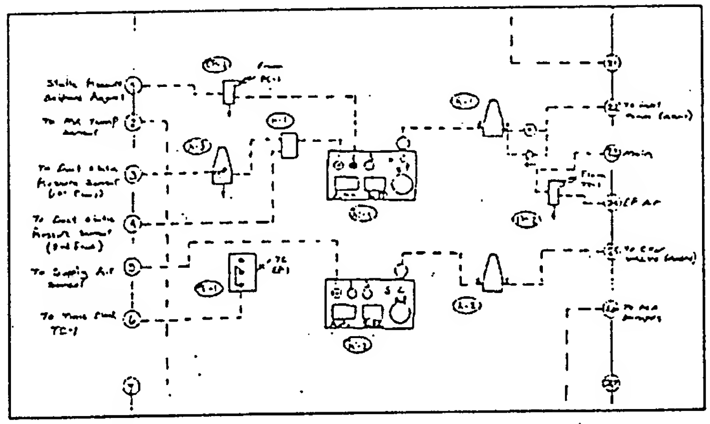
A Return to the Power of Simplicity

Within the building control industry, the past offered the simplicity of pneumatic engineering; the future is in the power and flexibility of electronics.

But the clarity and simplicity of the past have been sacrificed to the tedious line programming languages that prevail today.

This brochure introduces you to today's edge in building control -- a graphic programming language that harnesses yesterday's simplicity with tomorrow's power. A language designed to be universally understood. In addition to being easily understood, the EIKON® language gives you on-line diagnostics capability unheard of in the industry.

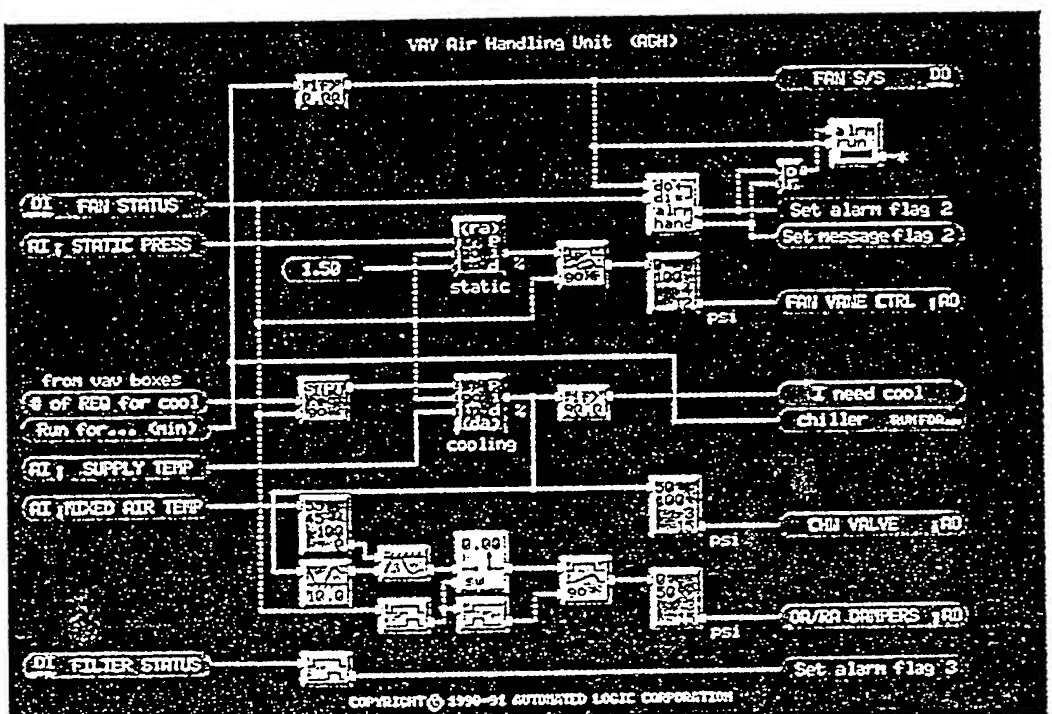
EIKON Graphic Programming. A return to the power of simplicity.



The Past ...

```
10 IF (FRZ.EQ.ALARM) THEN GOTO 80
20 IF (SFAN.NE.FRFON) THEN GOTO 90
30 DESWIT (0,OATMP, 65.0, 67.0, $LOC1)
40 DESWIT(1, MATMP, 50.0, 52.0, $LOC2)
50 LOOP(0,DATMP,VALVE, DASET, PC, 0, 1, 8.0, 4.0, 14.0, 0)
60 IF ($LOC1.EQ.ON.OR.$LOC2.EQ.ON)  THEN SET (4.0,DAMPER) ELSE DAMPER=VALVE
70 GOTO 100
80 OFF (SFAN)
90 SET ( 2.0,VALVE,DAMPER)
95  GOTO 10
100 IF(SFAN.EQ.OFF) THEN GOTO 700
150 IF(SECNDS.GT.400) THEN GOTO 350
200 IF(DCTSET-DCTSPR.LT.0.3) THEN GOTO 350
250 TABLE(SECNDS,SFVANE,0,3.0,400,15.0)
300 GOTO 450
350 TABLE(DCTSPR,FANSET,0.75,4.0,1.5,2.0)
400 LOOP(128,FANSPR,SFVANE,FANSET,PC,IC,DC,1,3.0,
3.0,15.0,0)
450 IF(SFVELP.GT.0.0) THEN SFCFM=AREA*SQRT(SFVELP) ELSE SFCFM=1.0
500 IF(RFVELP.GT.0.0) THEN RFCFM=AREA*SQRT(RFVELP) ELSE RFCFM=1.0
550 TABLE (SFCFM,RFSET,2000,1,10000,8000)
600 LOOP(128,RFCFM,RFVANE,RFSET,PC,IC,0,1,3.0,3.0,15.0,0)
650 GOTO 800
700 SECNDS=0
750 SET(2.0,SFVANE,RFVANE)
800 GOTO 100
900 IF(CRZ.EQ.ALARM) THEN GOTO 990
910 TODMOD(1,1,1,1,1,8,8)
920 TOD(1,1,08.00,17.00,SFAN)
930 IF(SFAN.EQ.OFF) THEN GOTO 100
940 LOOP(0,SPACE,VOUT,SPCSET,PC,IC,0,10,8.0,3.0,15.0,0)
950 TABLE(VOUT,DAMPER,5.0,10.0,14.0,14.0)
960 IF(DISAIR.LT.55.0) THEN VALVE=2.0 ELSE VALVE=VOUT
970 GOTO 1010
980 OFF (SFAN)
1000 SET(2.0,VALVE,DAMPER)
```

The Present ...



EIKON
GRAPHIC PROGRAMMING

EIKON®. The Next Step in Building Control.

Over the past decade, computerization rapidly changed the building control industry, empowering engineers with tremendous increases in application capability. But the very source of this power, the microprocessor's programmability, has created frustration and confusion.

Until recently, the only programming method available was the line-by-line programming language -- understood by computers, but awkward and confusing to anyone other than the programmer who wrote it.

Automated Logic®, an established leader in graphic operating systems that combine power with ease of communication, offers the next step in building control: EIKON Graphic Programming. EIKON's power is its familiarity -- a language that speaks in universal engineering terms. In fact, designing or reviewing an EIKON graphic function block is no different from reading a control drawing -- only easier and more informative.

EIKON liberates systems from line-by-line programming languages, enabling programmers to create or interpret control sequences easily and accurately. It communicates with a series of pull-down menus, on-screen information templates, and a library of more than 100 logic, math and control function microblocks -- all accessed using a computer mouse. And custom microblocks can be created using a line programming language.

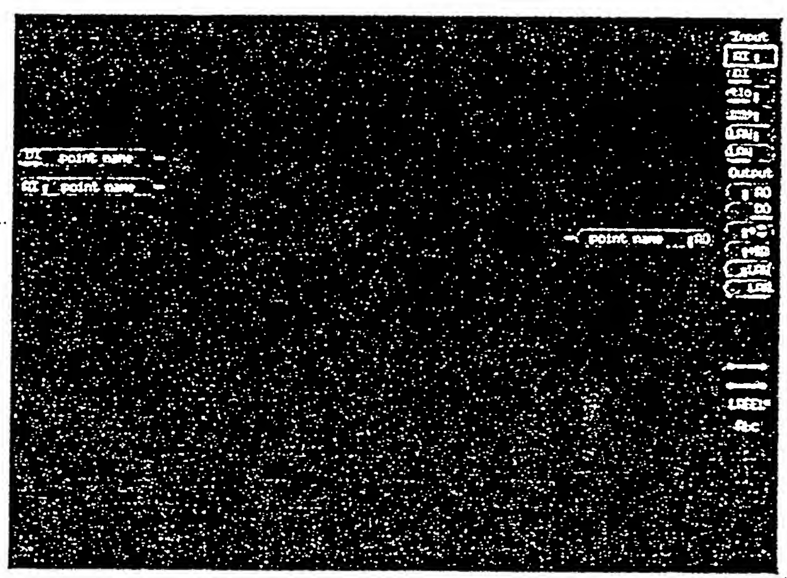
In the following example, a control sequence for a VAV Air Handling Unit is designed.

EIKON

GRAPHIC PROGRAMMING

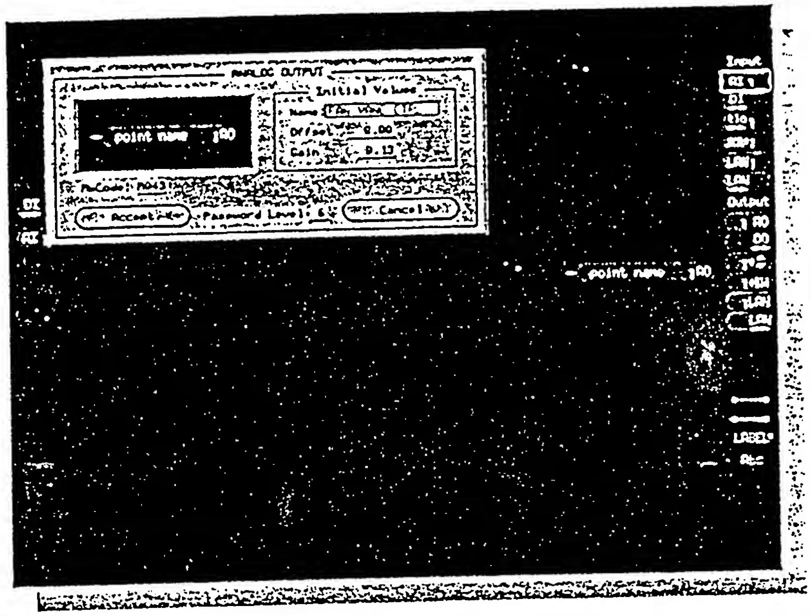
Step 1

Selecting from the menu bar, use the mouse to place the required I/O points. The inputs are placed on the right.



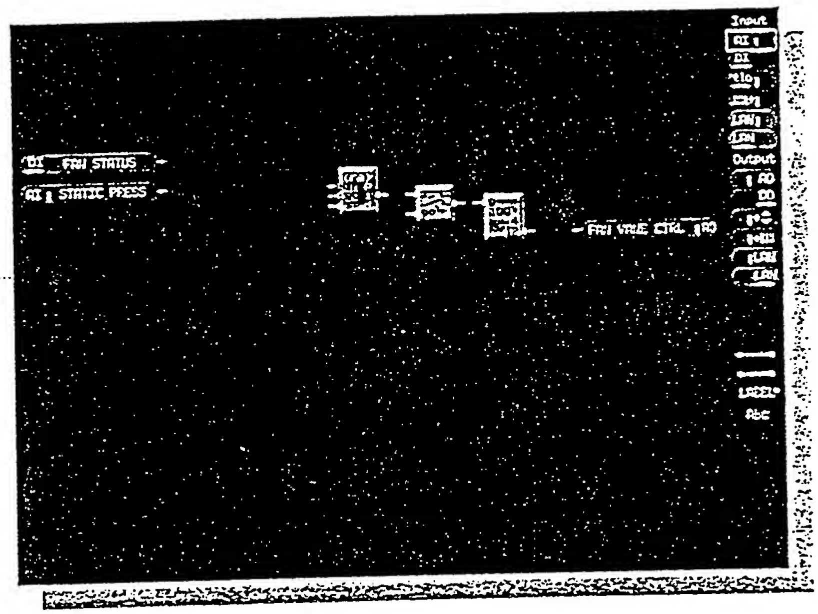
Step 2

Edit the individual point names to fit the application. Here we've named the analog output "Fan Vane Control."



Step 3

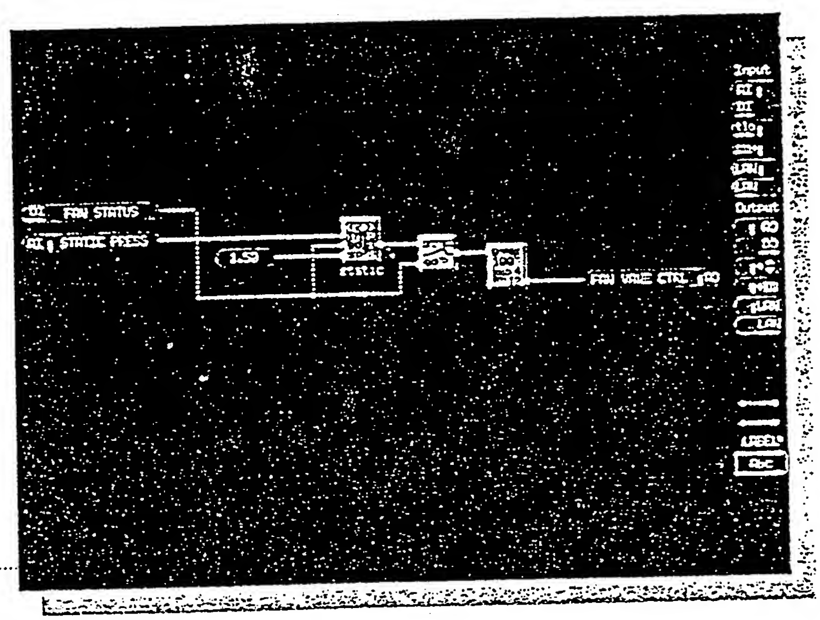
Selecting from the EIKON library, add the required microblocks. For this sequence, microblocks for reverse acting PID, ramp up/down control, and ratio have been selected.



Step 4

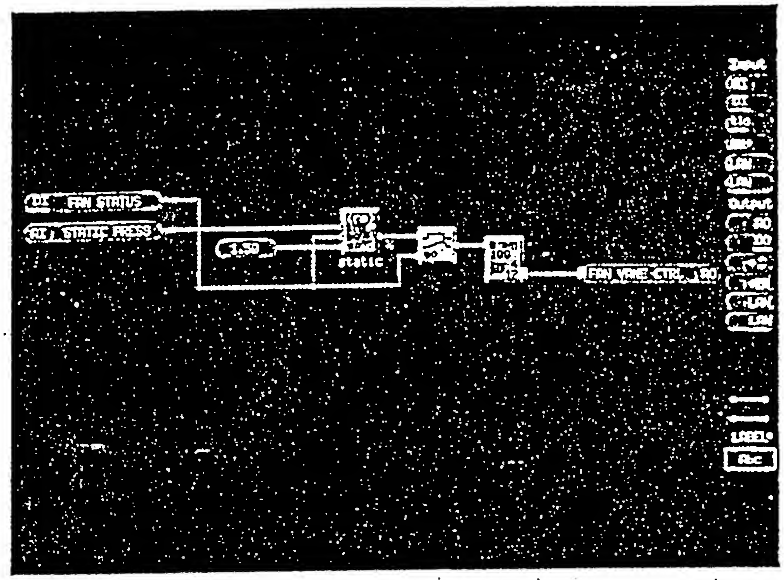
Connect microblocks with wires. Solid lines represent analog connections; dashed lines represent digital connections.

The duct static pressure input is fed to the input of the PID microblock. A fixed setpoint of 1.5" WC is then established using a parameter microblock. The output of the PID microblock is then fed through a ramp up/down microblock to prevent the inlet vanes from oscillating. The "go" inputs of the PID and ramp up/down microblocks are connected to the fan status input 1) to close the vanes when the fan is not running and 2) to prevent "wind-up" on the PID microblock. The output of the ramp up/down microblock is then passed through a ratio microblock which converts the unitless signal into an output range -- in this case 4-12 psi, which is then passed through to the inlet vane output.



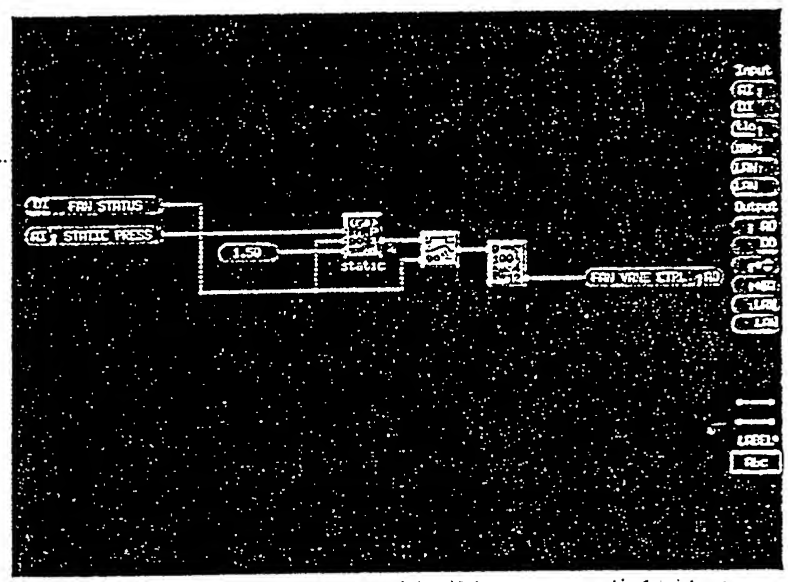
Step 5

Compile and check for errors. Errors are indicated by red flags which describe the location and type of error. In this case, EIKON® flags the error of an analog connection improperly connected with a digital wire.



Step 6

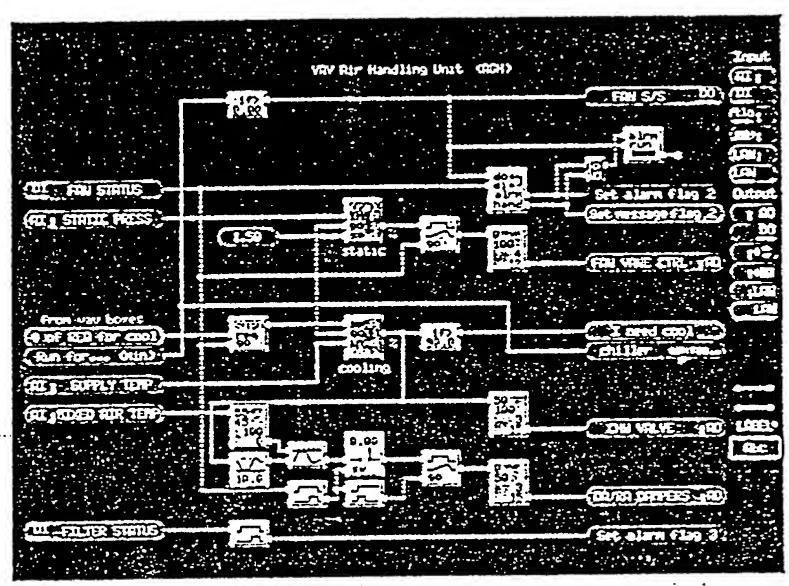
Make the necessary corrections and re-check for accuracy.



Step 7

Repeating steps 1 - 6, continue building the graphic function block until the operational sequence is complete.

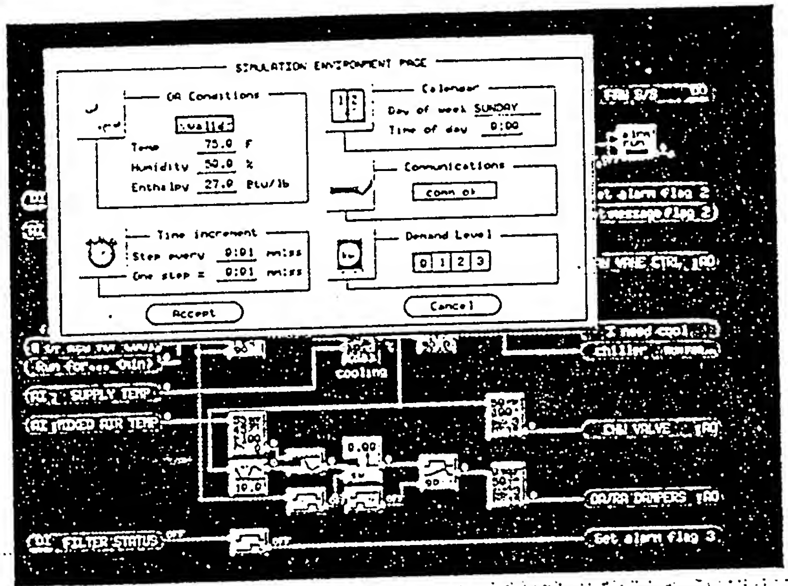
The final sequence for this VAV Air Handling Unit includes fan stop/start and setpoint based on requests, discharge air temperature control, mixed air temperature control and fan vane control.



EIKON
GRAPHIC PROGRAMMING

Step 8

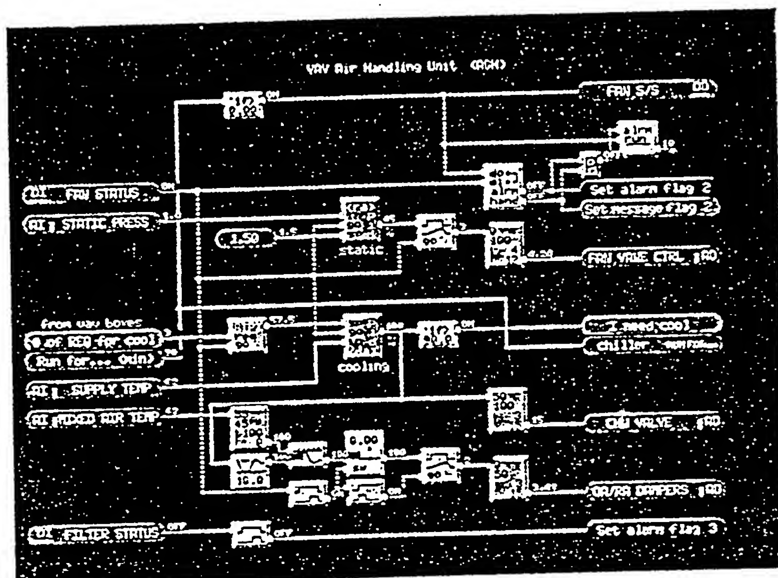
Next, EIKON simulation capability enables an engineer to run a complete performance evaluation on each operational sequence before it's installed in the real world of expensive mechanical equipment and tenant occupied spaces. The first step is to enter the global conditions under which the application is to be tested. This is done using the Environment Page which allows for any combination of conditions.



Step 9

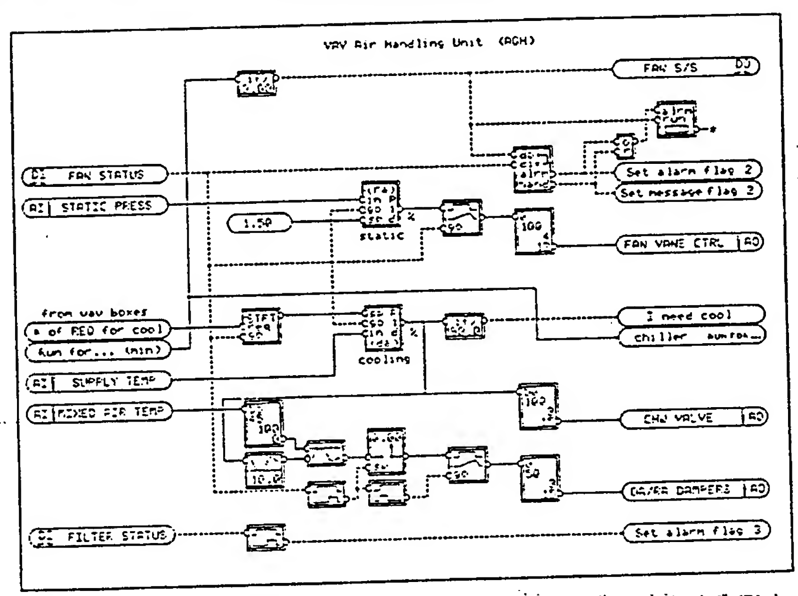
Simulate the entire application to check for proper performance. Operating information is highlighted in yellow. All input values are under the control of the operator in the simulation mode as well as the operating parameters of all micro-blocks. An operating sequence can be put through a torture test off-line before it's installed on-line.

Once the application has passed simulation, download it into the Automated Logic® control modules. After downloading, actual performance can be viewed on-line, providing a real-time diagnostic capability -- an industry first!



Step 10

Instant submittals and as-builts are part of the EIKON communications process. Because EIKON graphic function blocks are developed in the same format as control drawings, a simple push of a button provides a printout of each EIKON screen and generates up-to-the-minute project documentation.



An Arsenal of Information

There are two demands that must be met to ensure a prompt and accurate response in the event of an alarm condition: 1) immediate notification of the appropriate facilities personnel and 2) their ability to instantly access the information necessary to make the right decisions.

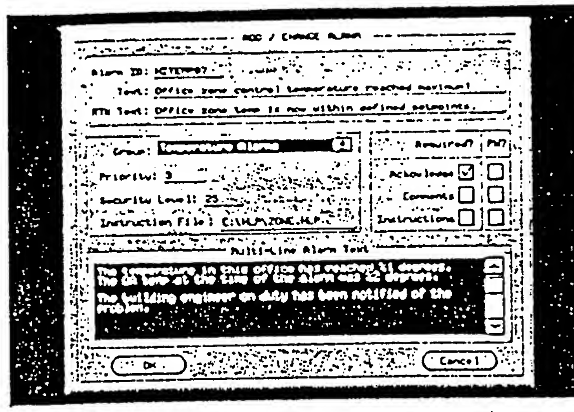
For over a decade, Automated Logic® has set the standard for systems which simplify complex control issues to give facilities operators the power to use their time managing their buildings rather than juggling data. Today, Automated Logic brings this same decision making power to alarms management with ALERT™, the most comprehensive alarm management system available for building operations.

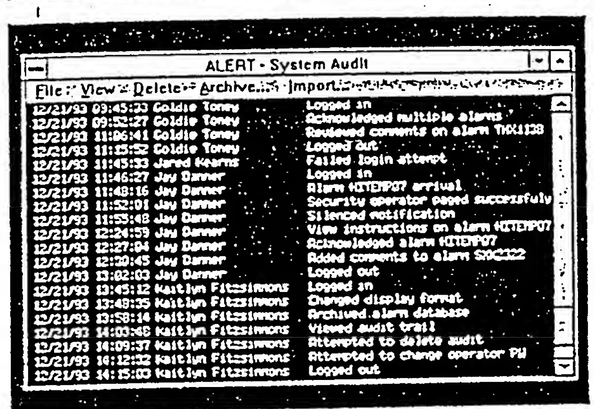
ALERT gives facilities managers the flexibility to define and prioritize alarm and event conditions based on individual building criteria. These event specifications include identification of the appropriate individual to be contacted, how and where they should be contacted based on the time of day, and what information they will need to properly assess conditions.

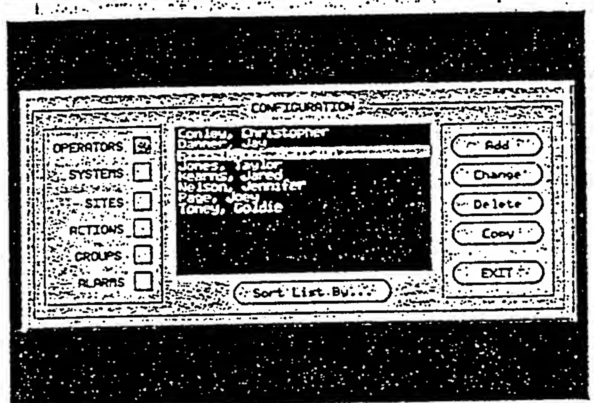
ALERT arms facilities managers with a sophisticated tracking and reporting capability that is efficient to manage and maintain. In the event of an alarm, this extensive accounting of facility activities is instantly accessed and efficiently communicated to provide appropriate historical information to assist in alarms condition analysis.

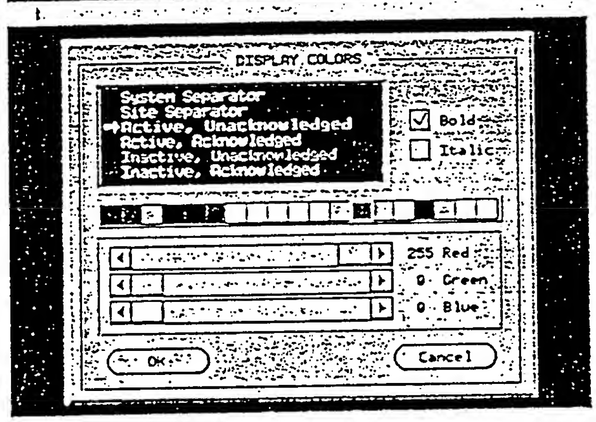
As in any truly effective management tool, ALERT's power is founded in its comprehensive approach to the job at hand. Take a look at the major feature areas of ALERT:

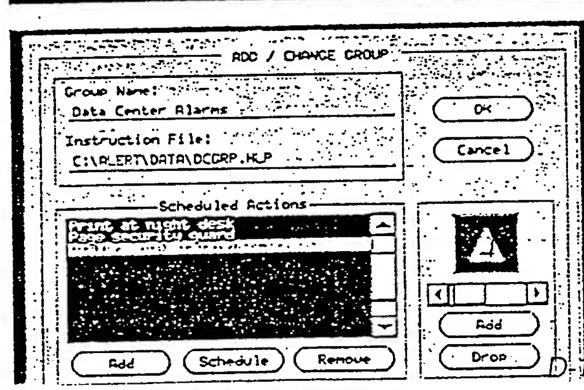
- Multi-level, password protected access.
- Operator-defined and prioritized alarms, established with an unlimited number of reporting actions.
- Reporting actions automatically triggered by alarm.

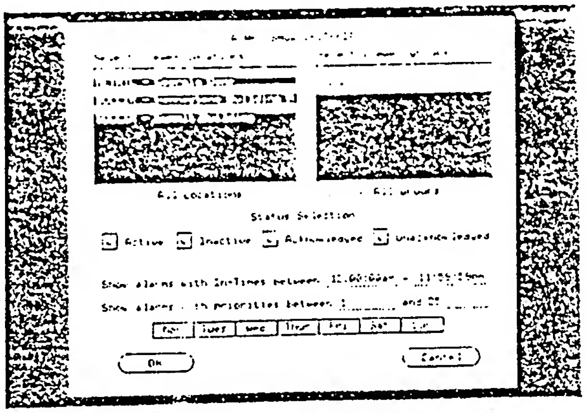


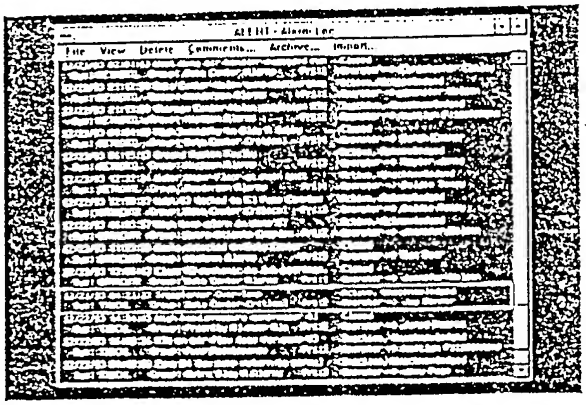


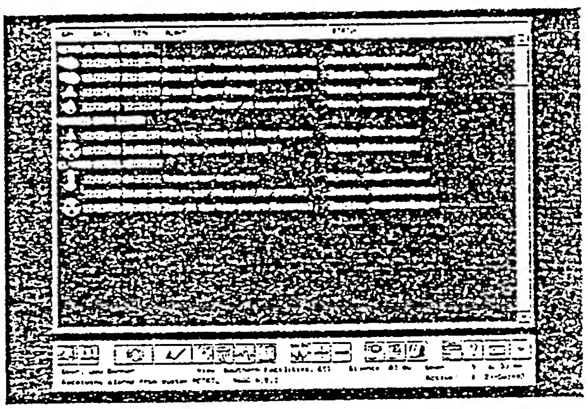


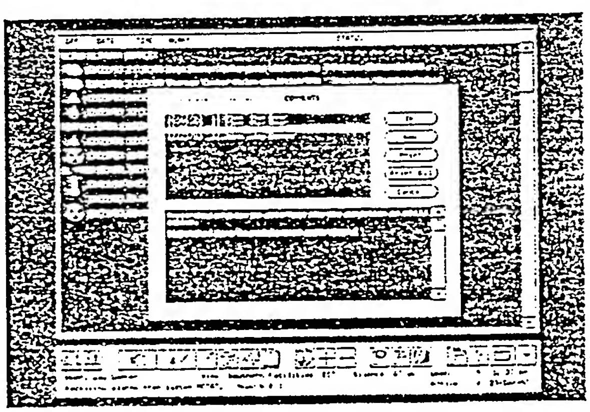


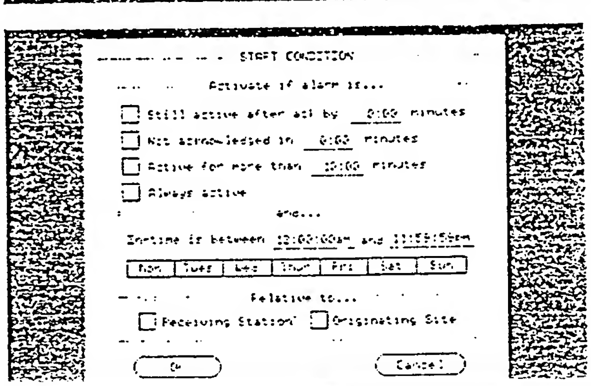








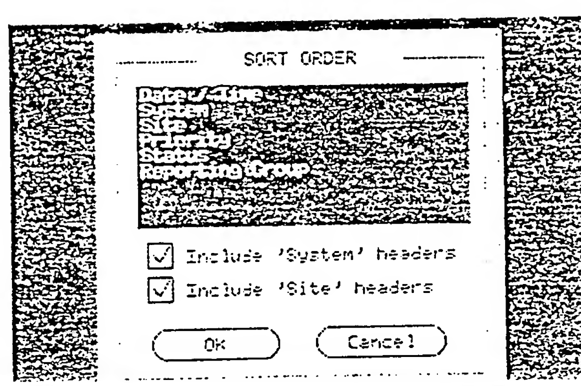


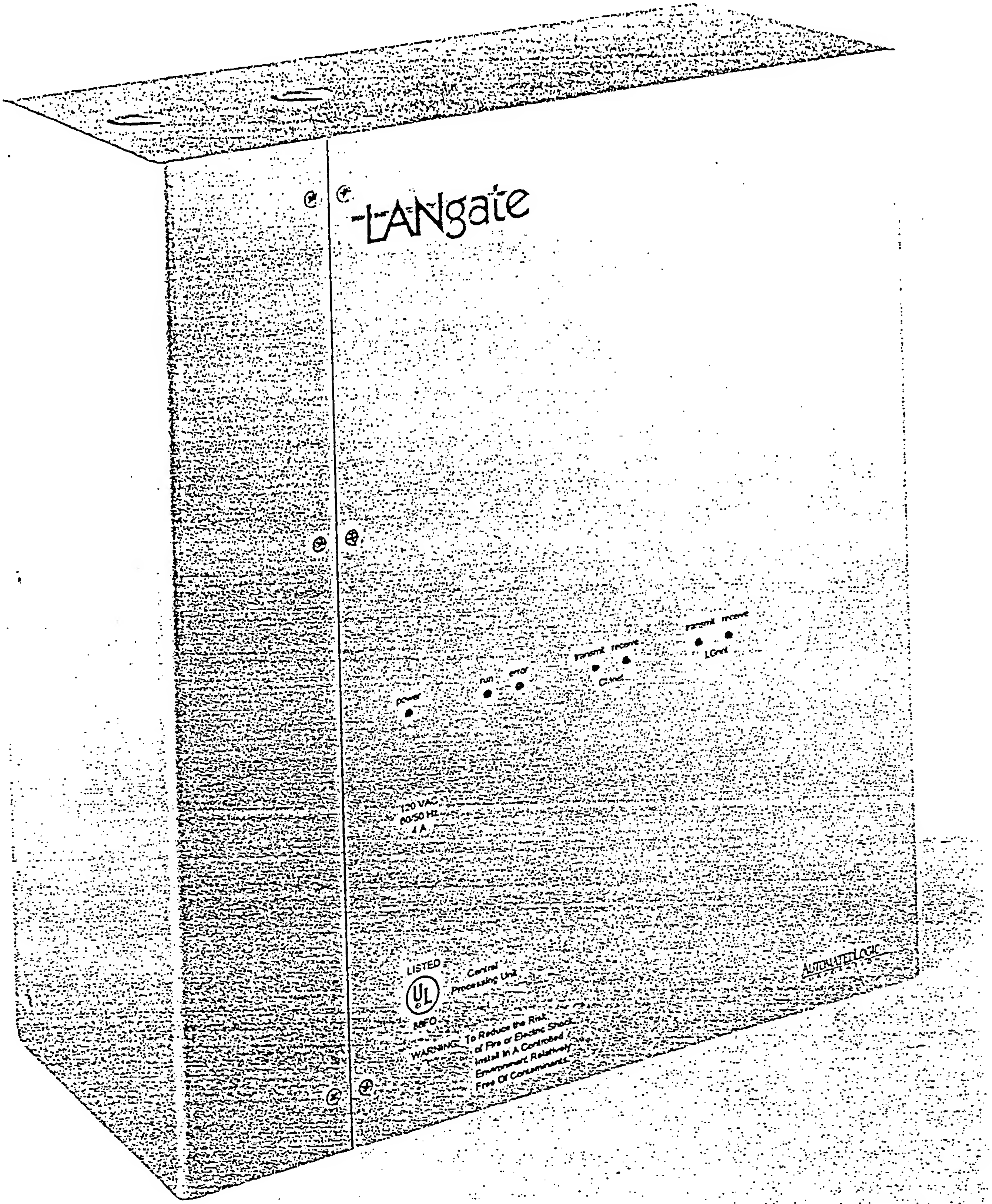


- Automatic recording of results in action log.
- Report delivery options to support printers, remote terminals, pagers and system commands.
- Alarm escalation based on time of day and operator interaction.
- Intelligent operator interface for on-screen alarm acknowledgment, viewing of reporting status, access to customized instructions and unique alarm comments.
- Remote access for alarm queries and acknowledgments.
- Multi-user access to shared database.
- Alarm database management utilities for import/export and record deletion.

Automated Logic's ALERT elevates alarms reporting from merely a control system feature to a fully integrated management tool. Contact your Automated Logic dealer for a demonstration of the ALERT Alarm Management System and experience a whole new level of control.

ALERT





LANgate™

Each LANgate supports a control module network of up to 100 control modules to access the global network. Up to 60 LANgates may be added to a global network. In addition to the two RS485 ports for network connections, LANgate provides two or four RS232 ports which can be connected to operator interface workstations, portable computers, or modems.

Powerful Network Solutions

In keeping with its system-wide philosophy of providing powerfully simple solutions for complex control issues, Automated Logic® delivers network solutions which are of the highest degree of efficiency, flexibility and reliability. These solutions are based on a network architecture which includes a Global Network (LGnet) through which multiple Control Module Networks (CMnet) may communicate.

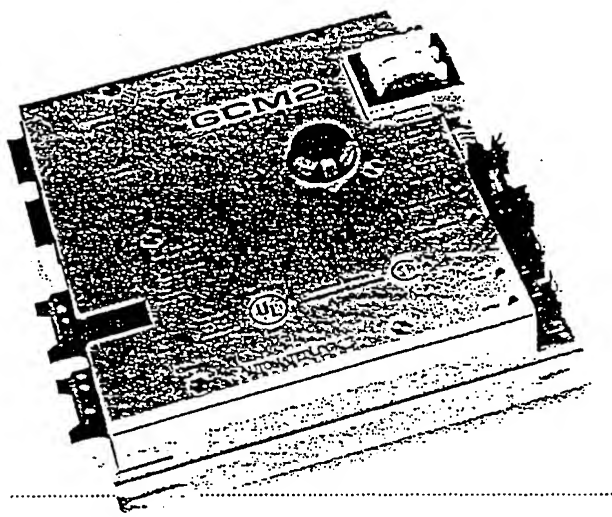
The CMnet is a peer-to-peer local area network which uses token-passing protocol to allow up to 100 control modules to communicate with one another with equal authority. Each CMnet has a gateway module which enables it to interact with the SuperVision operator interface, or with other CMnets, through the global network, for the sharing of information for the execution of facility-wide control strategies.

For single-network installations, the GCM2 module provides economical access for up to two simultaneous users, either local or remote.

For multi-network installations, the Automated Logic LANgate is positioned as a gateway between the control module network and the global network. One global network allows up to 60 LANgates, each of which can communicate with a control module network of up to 100 controllers, for a total capacity of 6,000 controllers per global network.

To ensure that multi-network communications can be established as flexibly as possible, network solutions are available for each of today's leading connectivity technologies. LANgate provides multi-network applications for Ethernet, ARCnet, Token Ring, Fiber Optics and RS485 communication options. These configurations may be implemented over a choice of fiber optic, twisted pair, or coaxial cable.

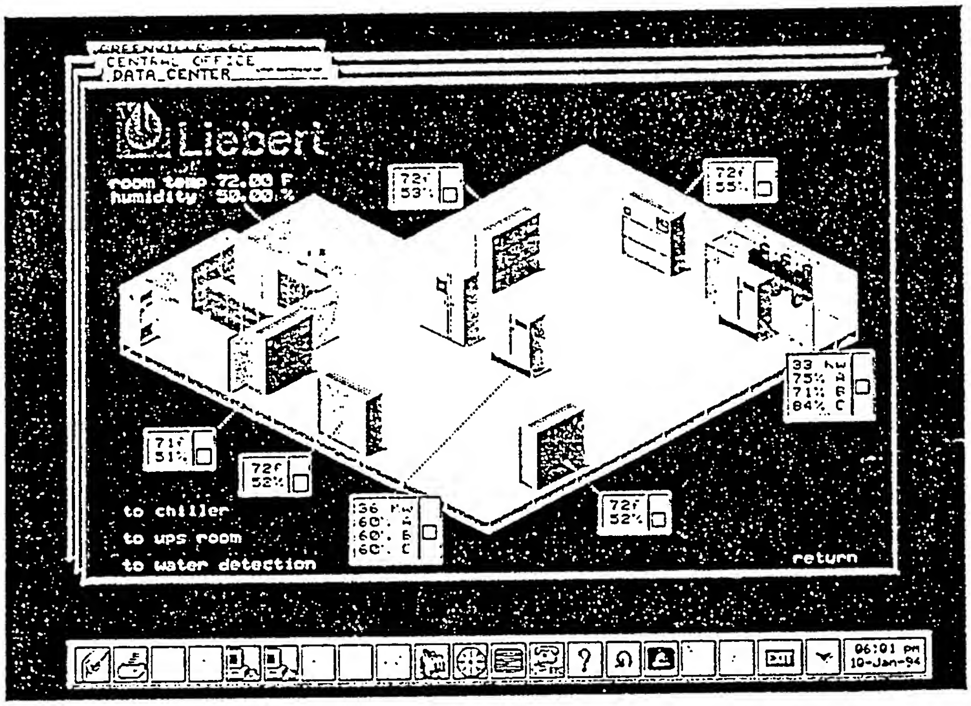
All network solutions provide for multi-user interface to the Automated Logic system from either local or remote locations.



GCM2

In a single-network application, a GCM2 provides the communications for a control module network to the SuperVision operator interface. The GCM2 communicates with the control module network through an RS485 port and with the operator interface using an RS232-C serial port. A second RS232 port provides for communication with another operator interface, portable field computer or modem.

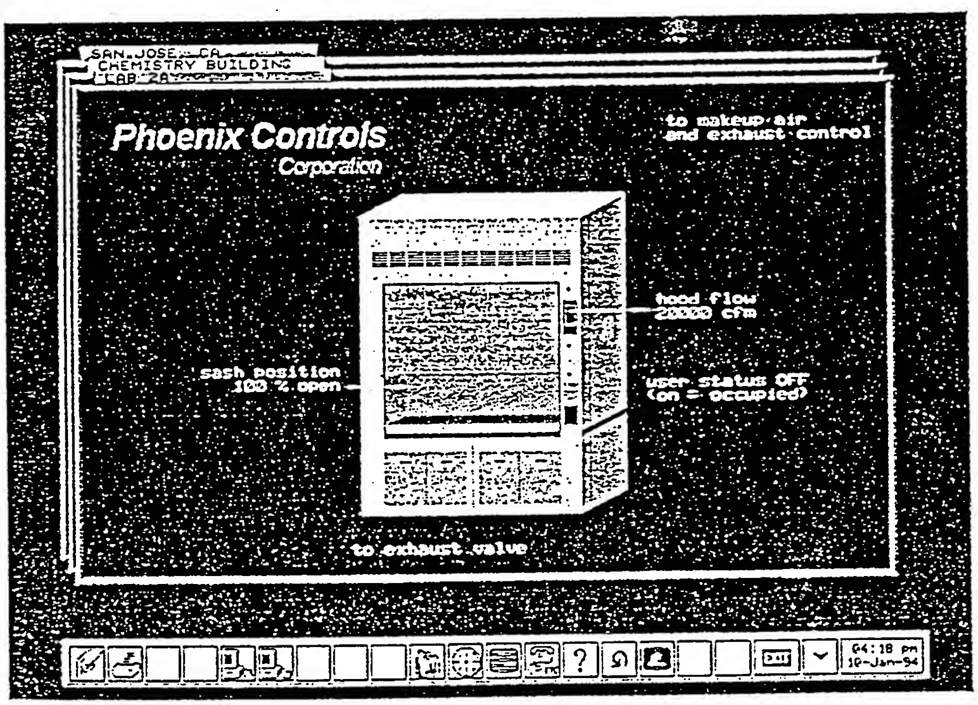
Automated Logic network solutions are in place in thousands of facilities worldwide and continue to evolve in response to advancements in communications technology.

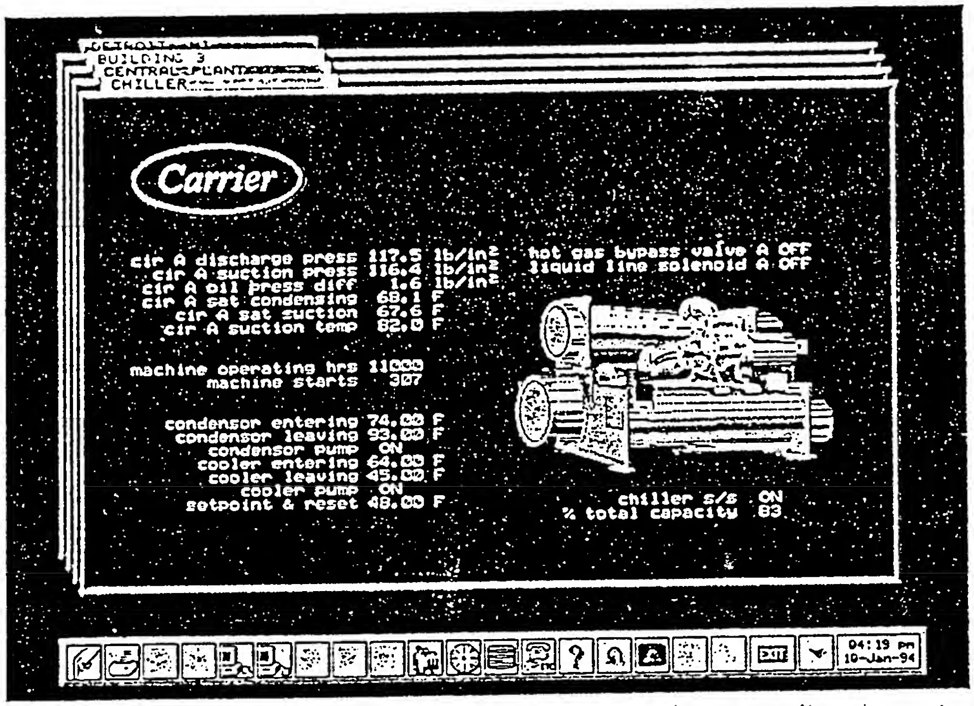


Building Subsystems Integration ... Powerful Solutions for Centralized Control

Long recognized as the industry leader for ease of operation and cost effective, reliable design, Automated Logic® has extended the power of both its EIKON® graphic programming system and SuperVision operator interface to other manufacturers' equipment with CONNECT™... a building subsystems integration package.

CONNECT establishes seamless interconnection with third party electrical and mechanical building systems including York International, Snyder General, Carrier Corp.,

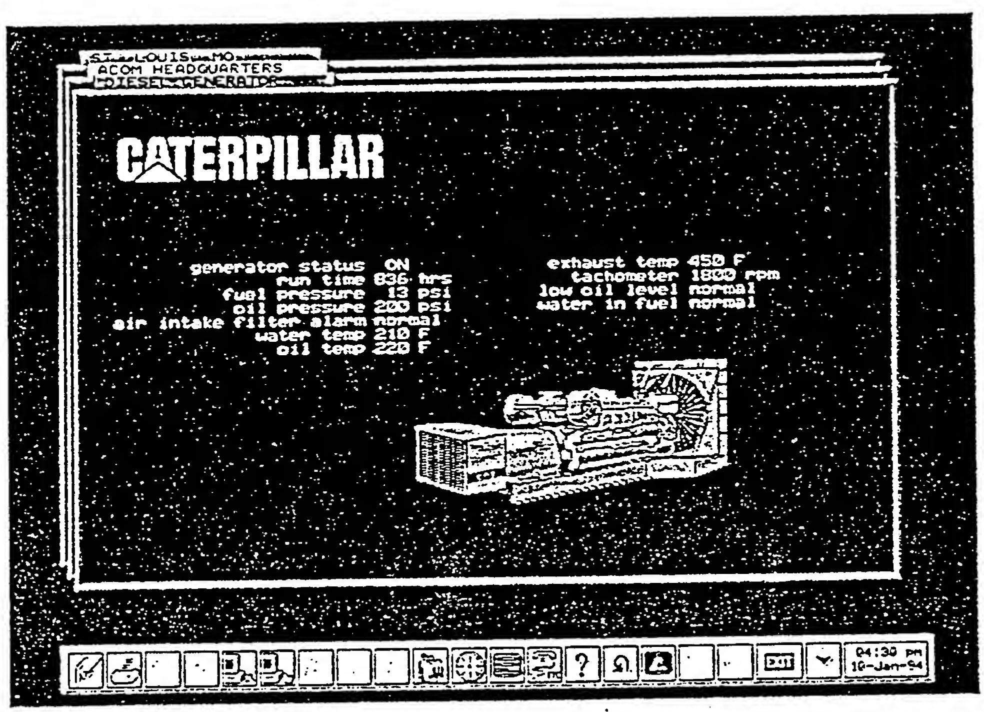




Phoenix Controls, Tek Air, Triad Technologies, Mammoth, Caterpillar, Modbus PLC, Liebert Corp., and a host of others.

With CONNECT, subsystems may be controlled and monitored through SuperVision and are graphically programmed with EIKON. Take a look at just a few of the examples of how CONNECT is simplifying complex building systems control.

The list of manufacturers for which Automated Logic has developed an integration package is growing daily. Contact your local Automated Logic representative for a current listing of CONNECT integration applications.



"The solution to the problem should be as simple as possible...but no simpler."

- Albert Einstein

Automated Logic® brings logic and order to the complexities of managing your building through the genius of simplicity.

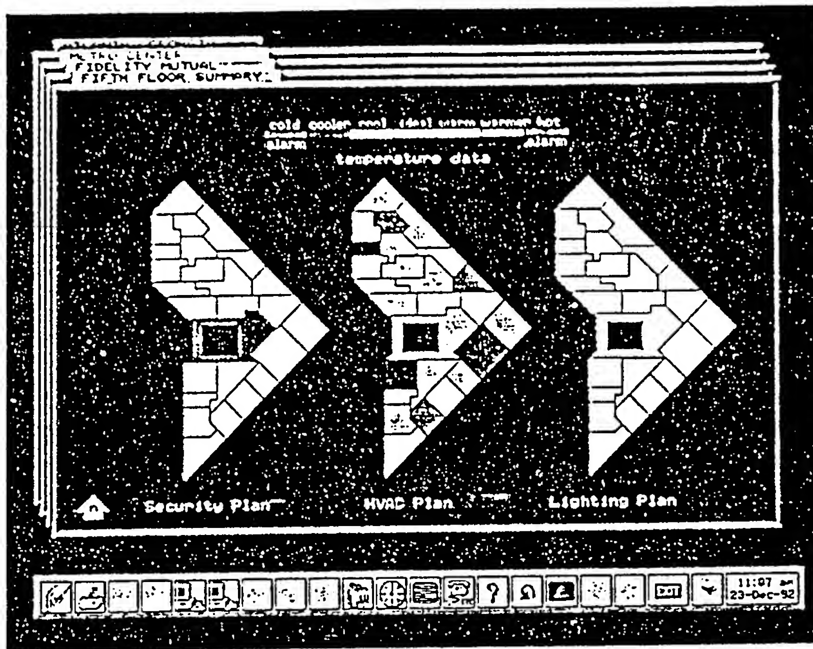
Since its beginning in 1976, it has been the goal of Automated Logic to design powerful building control systems that are simple to master.

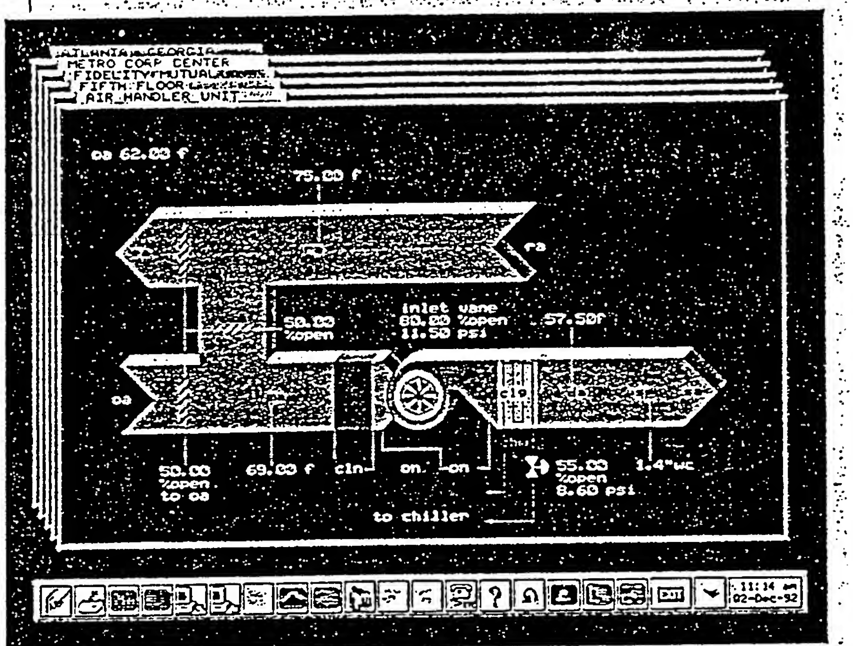
In 1985, Automated Logic introduced SuperVision... a graphic operating system for its Direct Digital Control (DDC) building control system. This design resulted from the combination of a decade of experience with building systems and the goal of giving the user maximum power through the simplest effort.

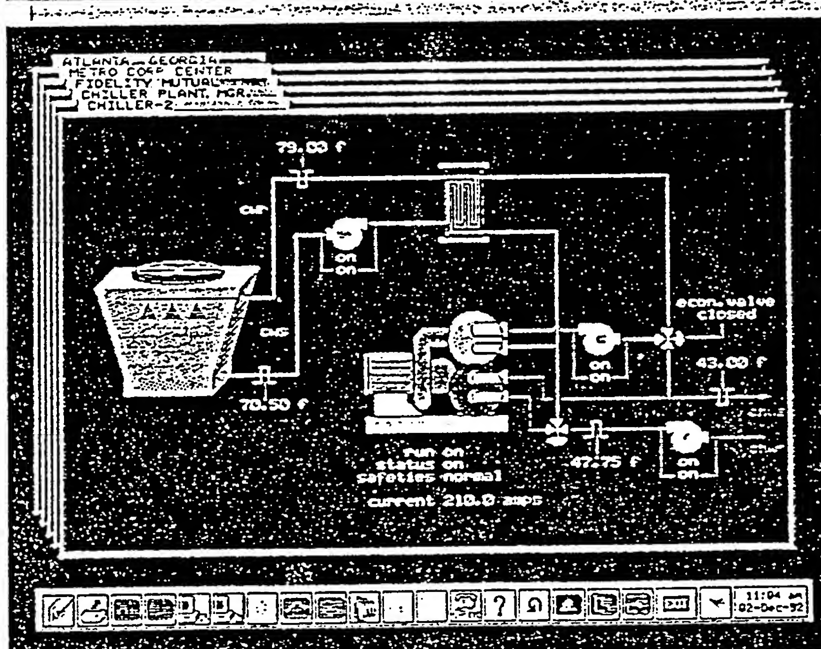
This high-powered, high-resolution operating system enables facility operators to efficiently implement complex control strategies and monitor their performance through on-screen display of real-time performance.

Today, Automated Logic and SuperVision continue to set the industry standard for ease of operation and simplification of complex control issues.

SUPERVISION
OPERATOR INTERFACE







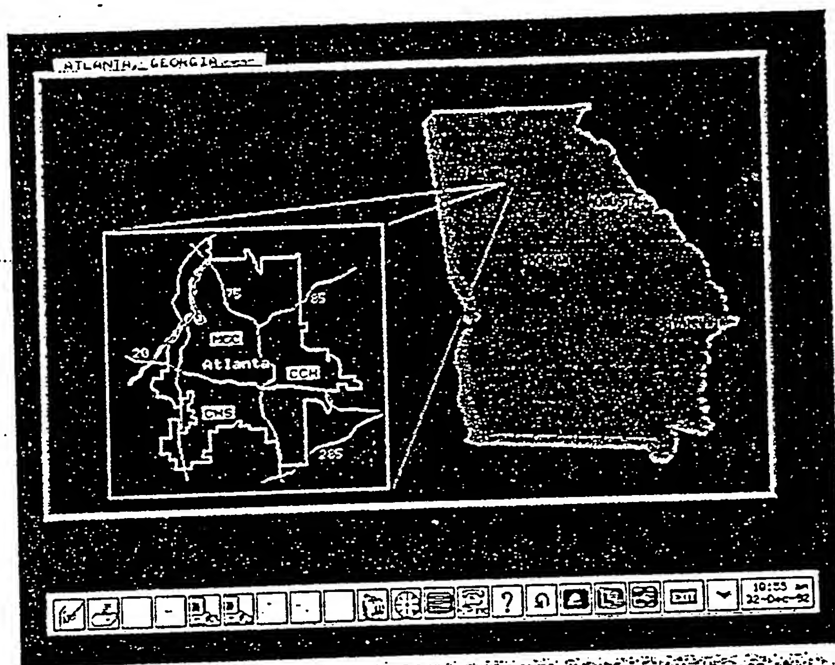
A Simple Decision

Automated Logic® Corporation designed SuperVision to be a management tool that allows building managers to spend their time making decisions, not juggling data.

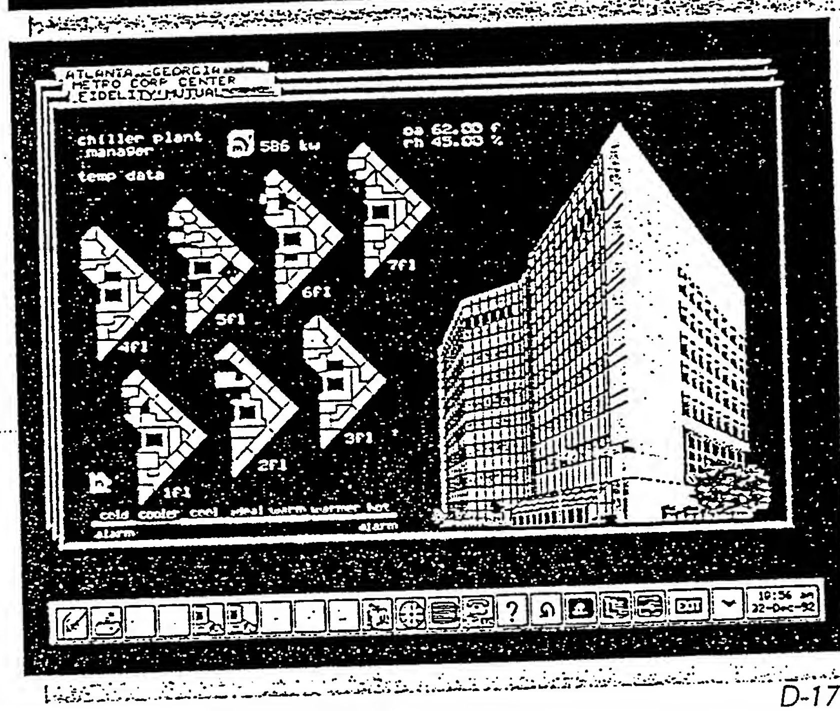
With SuperVision, you move rapidly through the system using a computer mouse, selecting activities from a series of pop-up menus. Each requested screen change takes you through the building in a logical manner. Information is communicated quickly through colors that signify comfort and operational conditions, which are operator-defined based on use and occupancy of space.

As an example of how quickly information can be obtained, follow this sequence of screens:

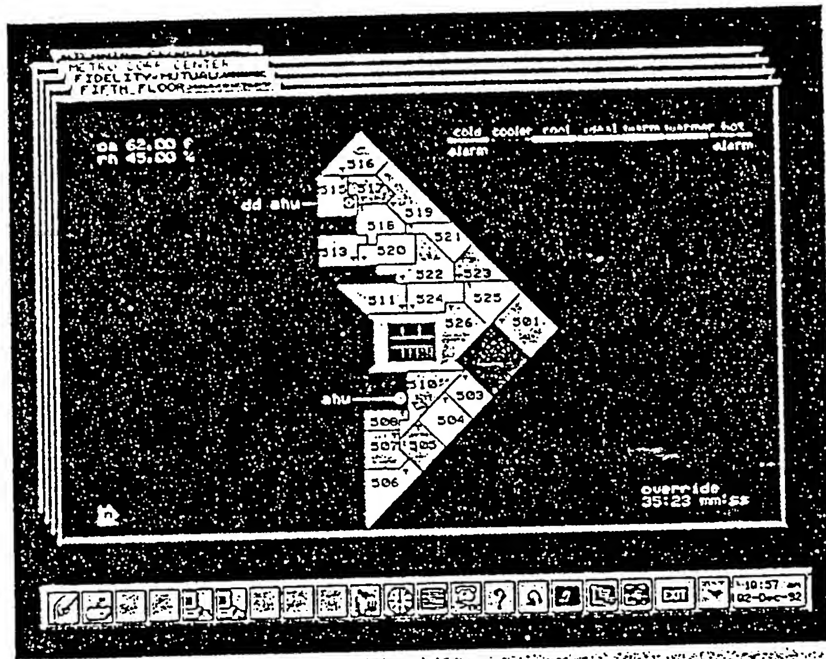
You are the manager of the office park shown on the map. You want to inquire about the comfort condition of a building. Point the arrow and push the button.



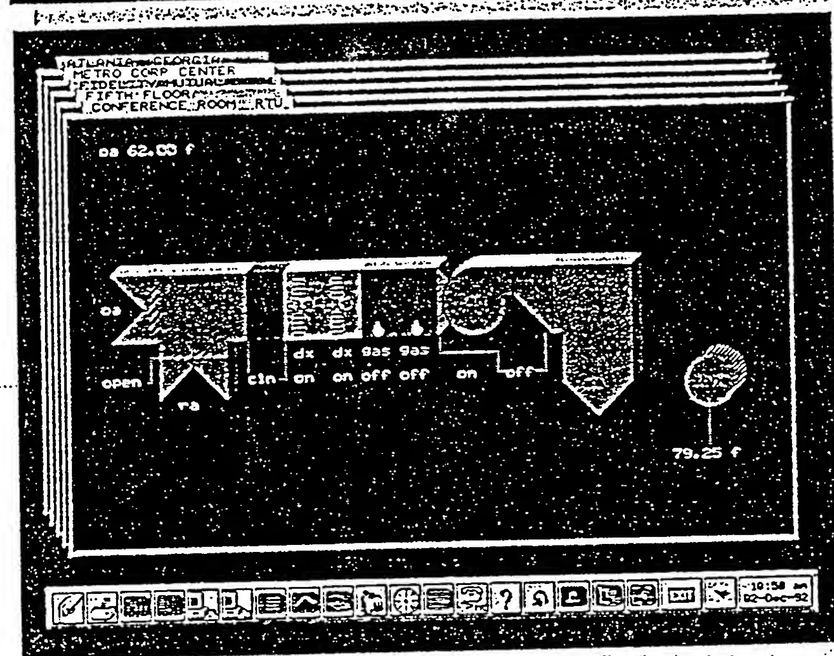
You are looking at more than one hundred comfort zones contained in the seven floors of the building. Where is the alarm condition? A quick glance summarizes the operation of the entire building. A problem zone on the fifth floor is easily identified. For a closer look, point the arrow and push the button.



The problem exists in the conference room. Point the arrow and push the button.



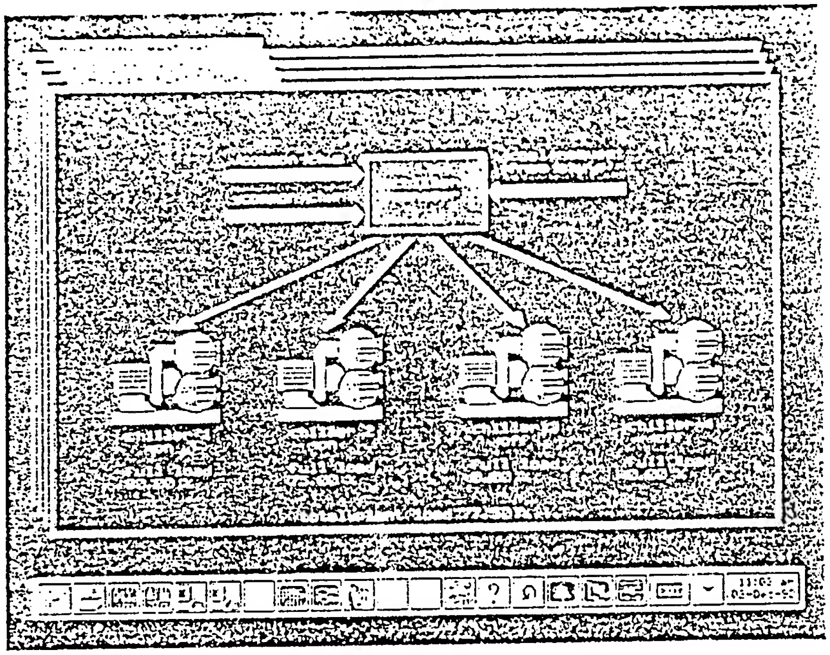
The room temperature is too high. You see a graphic representation of the actual equipment serving the conference room. The equipment is functioning properly, but there is no air movement in the duct. Maintenance can be dispatched to check the operation of the fan.

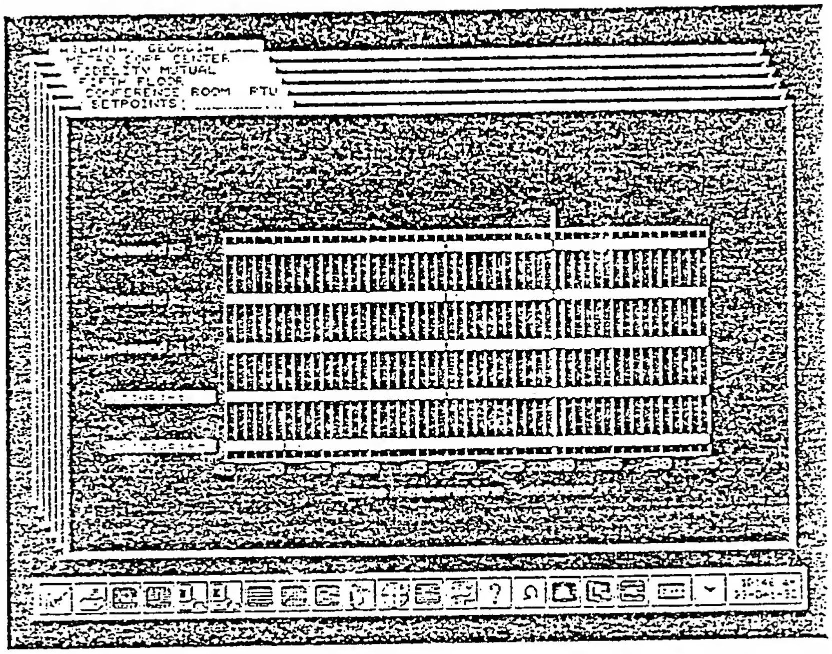


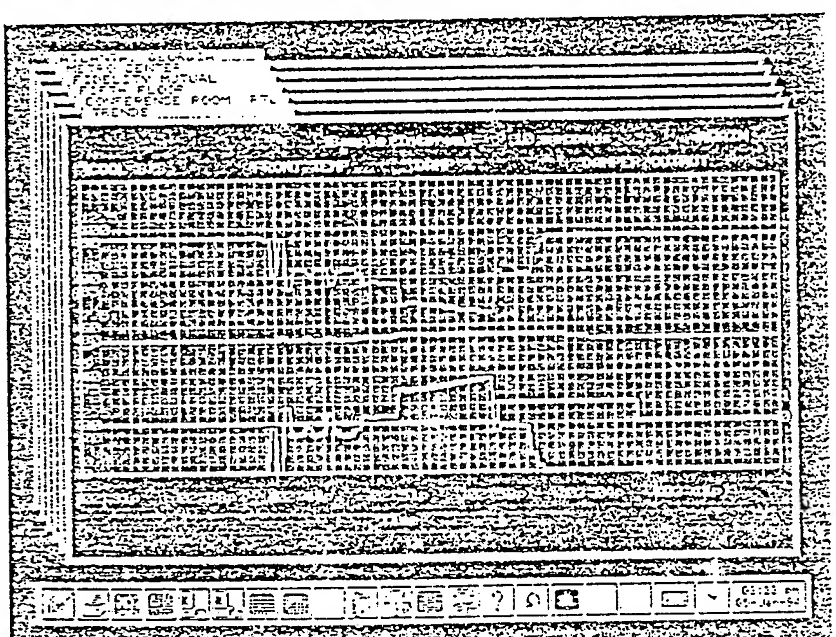
No matter how complex the control question, you receive information quickly and can execute your decision with the same reliability and speed.

Compare the SuperVision solution to the time consumed by your current method and decide how your valuable effort could best be spent.

A simple decision.







The Power to Simplify a Complex Problem

A multiple chiller plant with water side economizer and heat recovery, controlled with ramp up, ramp down, lead/lag, and supply water reset functions is unquestionably complex. Even the solution that is as simple as possible is not so simple. But no system is so complex that it cannot be divided into smaller, more understandable components for simplified, effective management.

SuperVision clearly presents the interrelationships between individual components so the logic and flow of the system as a whole is easily understood. As a result, the performance of a complex chiller plant is made simple by an orderly presentation of its individual component parts.

To the skilled technician, just the phrase "tuning a PID loop" often represents a time-consuming, trial and error process. SuperVision provides a superior solution to PID loop control. Each component of the output signal (the Proportional, Integral and Derivative), is displayed on a real-time basis and, when combined with graphic trending of actual performance of the control loop, the technician efficiently masters the tuning process.

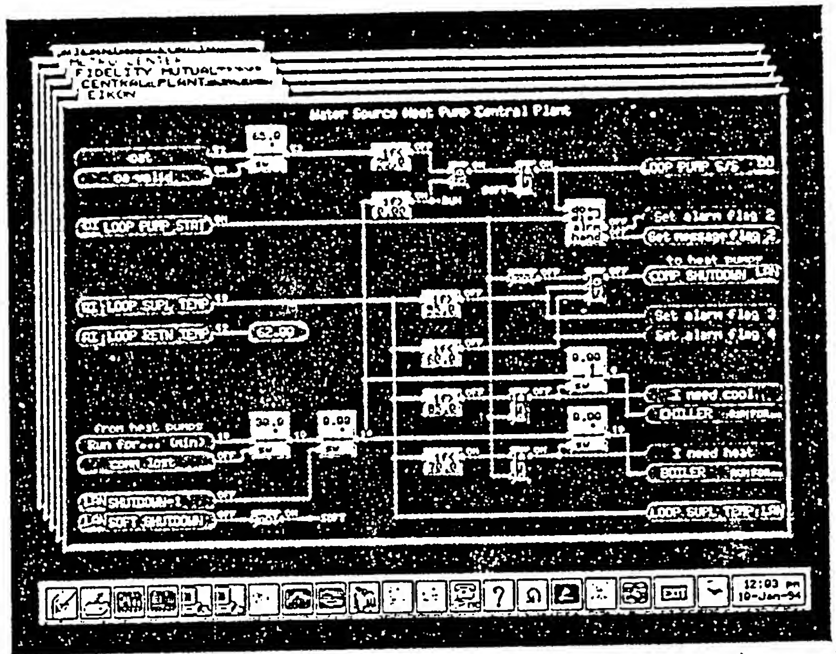
Traditionally, temperature setpoints are not complicated, but are awkward to read and work with when presented in numerical, columnar form. With SuperVision, each comfort zone has fifteen separate temperature setpoints available that are scaled on a bar graph and changed quickly through an interactive, mouse-driven graphic.

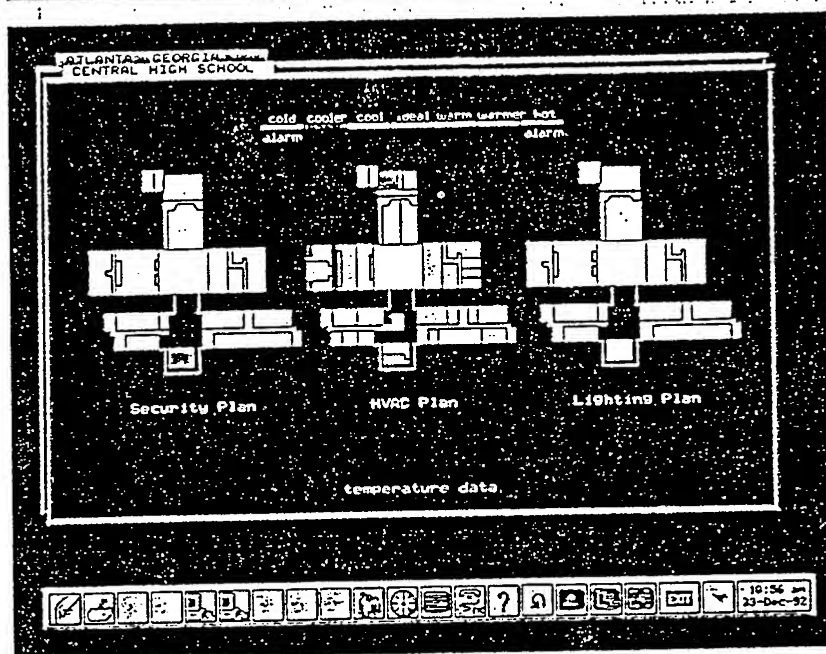
SuperVision can also simultaneously trend the temperatures of all comfort zones and display this information graphically, in operator-defined increments.

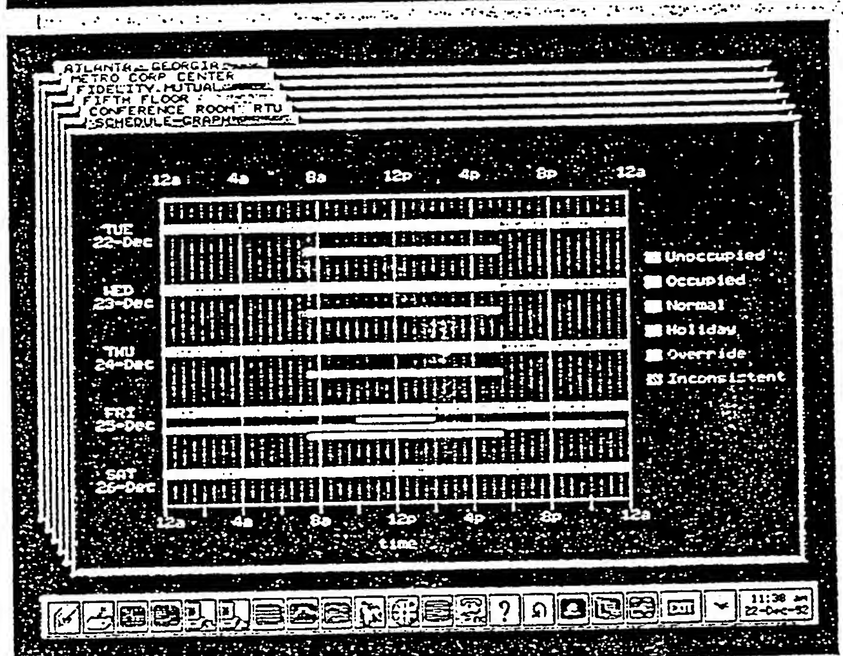
One of the most powerful tools available through SuperVision is EIKON® on-line diagnostics. This feature is an industry first and provides significant enhanced value to building managers.

With such features as ten levels of password protection, menu-driven operation, quick communication of multi-zone comfort conditions, and a scheduling capability second to none, SuperVision enables building managers to greatly enhance the performance of their facilities ... simply, accurately and cost effectively.

The problem-solving power of SuperVision is yours at the push of a button.







SUPER VISION

OPERATOR INTERFACE

RADIO COMMUNICATION PRODUCTS

EST is Solving Com

The Radio Solution

ESTeem wireless modem products provide a "Wireless Solution" by eliminating conventional hardwiring or leased phone lines.

All of the ESTeem models come with the industry standard RS-232C and RS-422 asynchronous communications ports to give the user a new dimension to "Local Area Networking".

Our packet burst, frequency agile VHF and UHF communications products allow the user to create a "Radio Area Network" of up to 254 users on a single frequency. The packet burst communications using a Synchronous Data Link Control (SDLC) technique was chosen to give the system very high data integrity in high noise industrial environments. The ESTeem incorporates a method of error checking that provides received data accuracy of greater than one part in 100 million.

Increased Operating Range

Internal Digi-Repeater features allow the user to increase operating range by relaying transmission through a maximum of three ESTeems to reach the destination ESTeem. An ESTeem can operate as an operating node, a repeater node, or both simultaneously for added flexibility.

Inventory Control

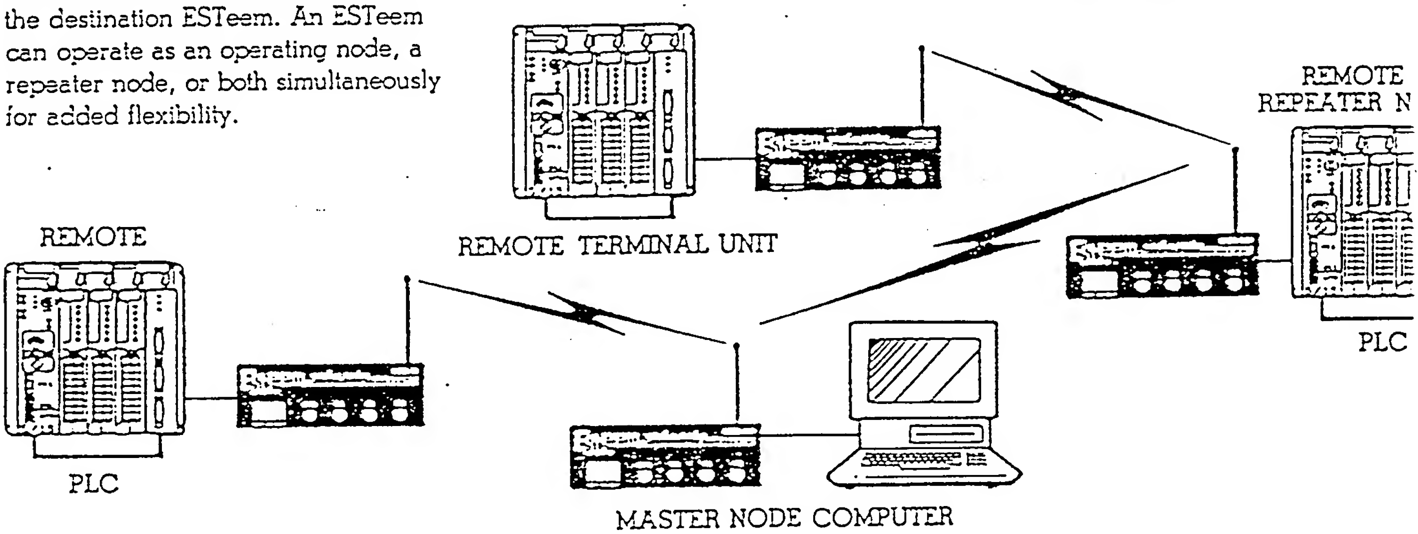
Transmission Security

"Private Data Communications" is provided by the use of ESTeem firmware SDLC, bit compression, and Manchester encoding techniques. The user can define over four different security code and communications parameter groups that allow communication access to the "Radio Area Network". If higher security is required, the ESTeem is compatible with asynchronous Data Encryption Standard (DES) encryption devices.

User Friendly

The ESTeem has over a hundred internal software commands to allo\ the user to easily configure the uni: for any application or mission. The ESTeem set-up parameters are save in its own non-volatile memory.

Federal Appl:



ELECTRONIC SYSTEMS TECHNOLOGY

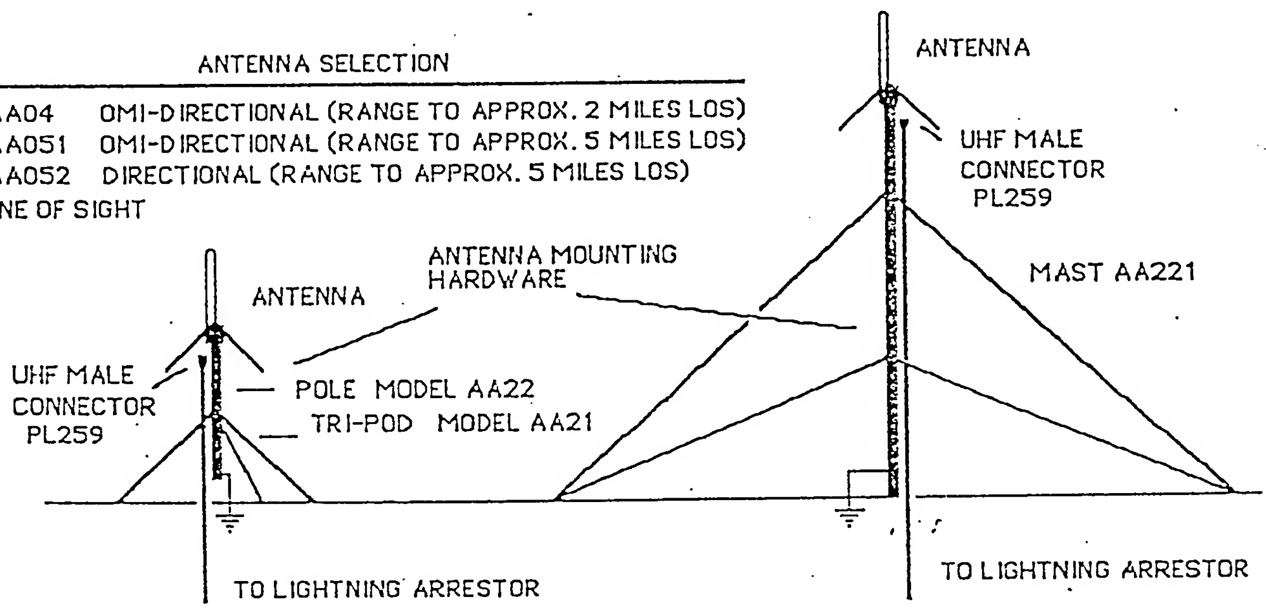
TECHNICAL BULLETIN
VHF ANTENNA SETUP

415 N. QUAY STREET
KENNEWICK, WA 99336

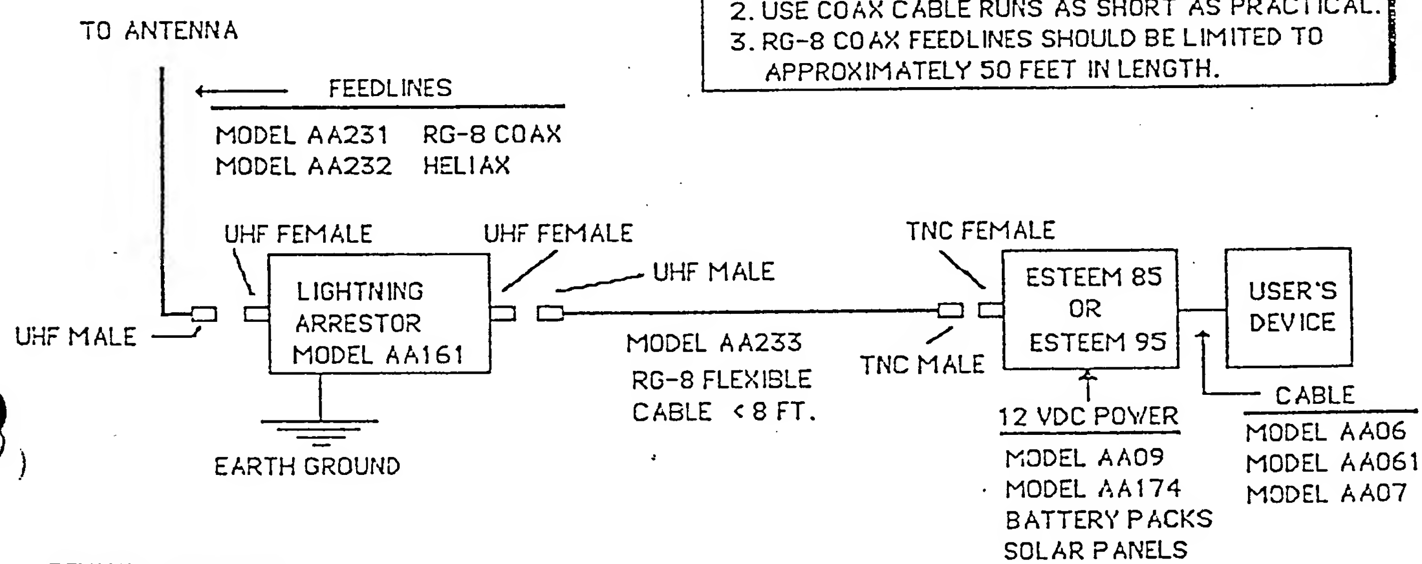
TYPICAL VHF ANTENNA INSTALLATION DIAGRAM
OUTDOOR FIXED BASE SITE

ANTENNA SELECTION

MODEL AA04 OMI-DIRECTIONAL (RANGE TO APPROX. 2 MILES LOS)
MODEL AA051 OMI-DIRECTIONAL (RANGE TO APPROX. 5 MILES LOS)
MODEL AA052 DIRECTIONAL (RANGE TO APPROX. 5 MILES LOS)
LOS = LINE OF SIGHT



NOTES:
1. VAPOR WRAP ALL EXTERIOR COAX CONNECTIONS
2. USE COAX CABLE RUNS AS SHORT AS PRACTICAL.
3. RG-8 COAX FEEDLINES SHOULD BE LIMITED TO APPROXIMATELY 50 FEET IN LENGTH.



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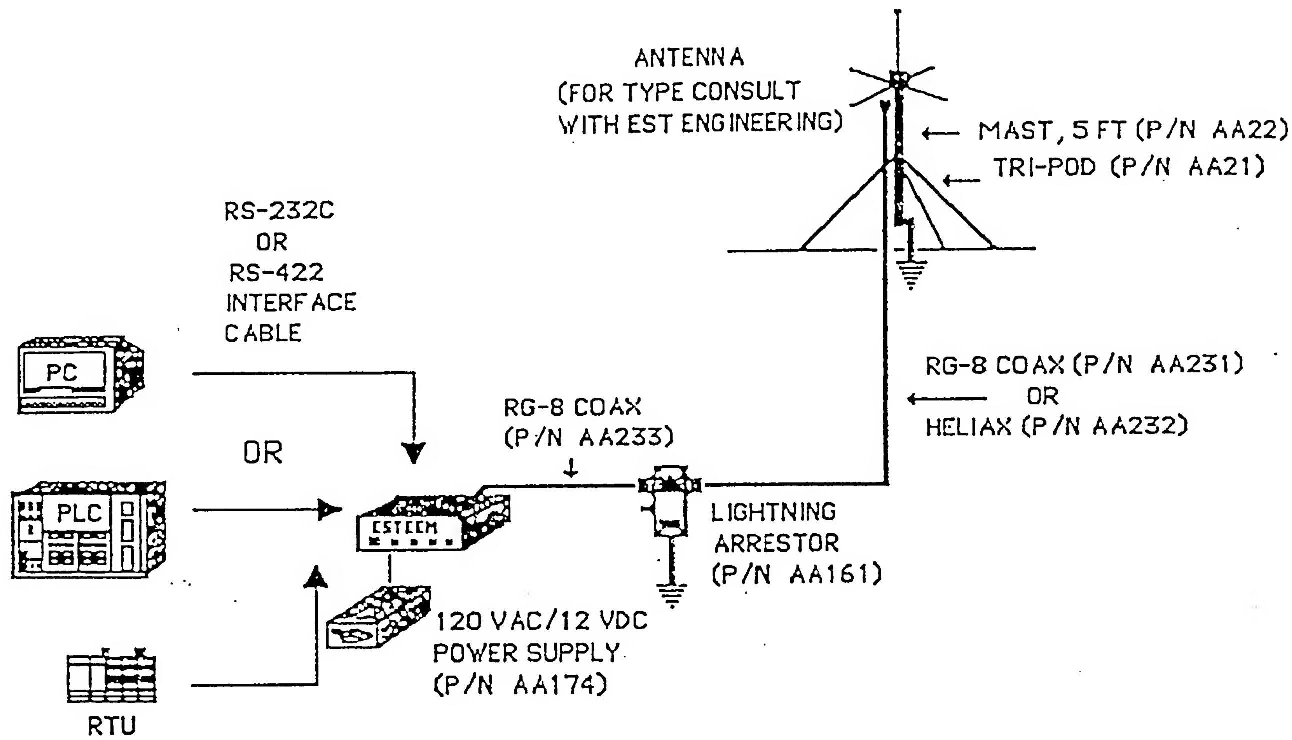
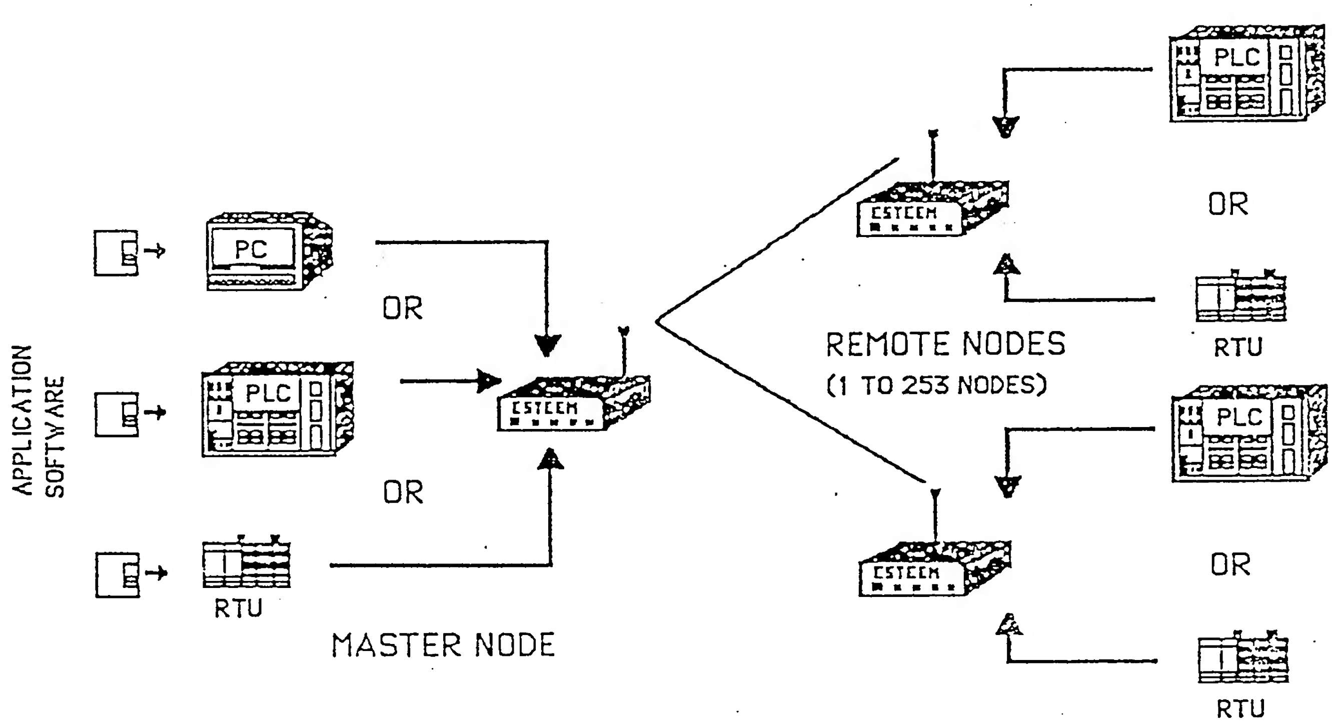


TYPICAL NODE BLOCK DIAGRAM



TYPICAL SYSTEMS APPLICATION

TECHNICAL BULLETIN
EST/PLC INTERFACES

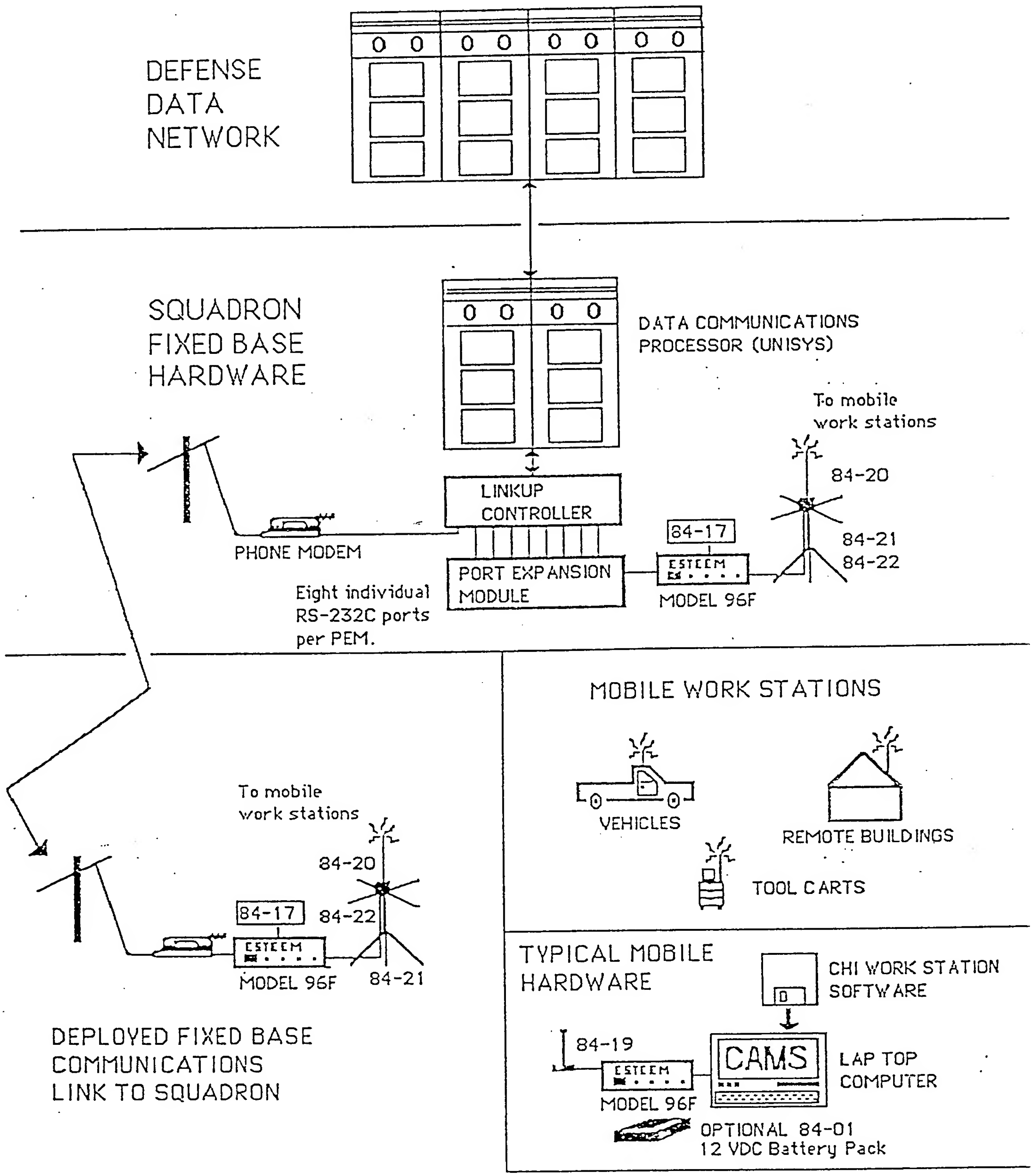
ELECTRONIC SYSTEMS TECHNOLOGY

415 N. QUAY STREET
KENNEWICK, WA 99336

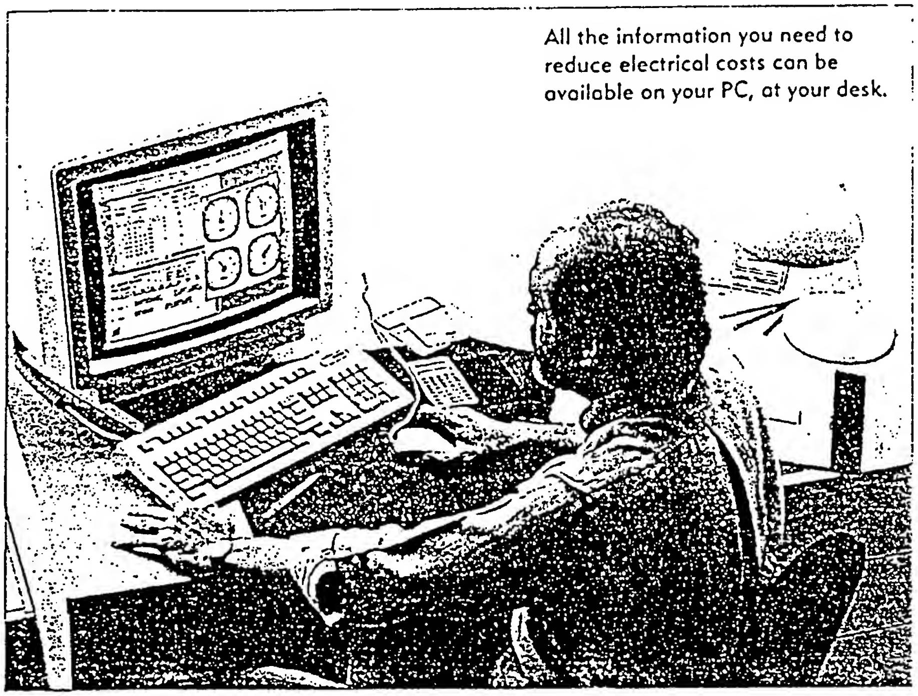
Listed below are the software interfaces internal to the ESTeem firmware that we have developed for the following programmable logic controller companies. EST has available Technical Bulletins and Engineering Reports to aid the user in hardware/software interfacing.

ABB KENT-TAYLOR	EST Engineering Report 93-011
ACROMAG INC.	EST Engineering Report 94-006
ALLEN-BRADLEY COMPANY	EST Engineering Report 90-023
BARRINGTON, INC.	EST Engineering Report 90-013
FOXBORO COMPANY	EST Engineering Report 91-023
JOHNSON CONTROLS, INC.	EST Engineering Report 91-012
GENERAL ELECTRIC COMPANY	EST Engineering Report 91-010
MODICON, INC.	EST Engineering Report 90-022
OPTO-22 PROTOCOL	EST Engineering Report 93-010
PHOENIX CONTACT INC.	EST Engineering Report 94-001
ROSEMOUNT INC. (HART)	EST Engineering Report 94-005
SQUARE D COMPANY	
SY/MAX PRODUCTS	EST Engineering Report 88-010
MODEL 50 PRODUCTS	EST Engineering Report 91-017
POWER LOGIC PRODUCTS	EST Engineering Report 91-014
TEXAS INSTRUMENTS	EST Engineering Report 91-021
TOSHIBA	EST Engineering Report 91-011
TURNBULL CONTROL SYSTEMS	EST Engineering Report 93-001
WESTINGHOUSE ELECTRIC CO.	EST Engineering Report 91-013
FOR PLC'S NOT LISTED REQUEST	EST Engineering Report 92-010

CORE AUTOMATED MAINTENANCE SYSTEM



CIRCUIT MONITORING PRODUCTS



All the information you need to reduce electrical costs can be available on your PC, at your desk.

Cutting electrical costs with information

How power monitoring and control systems help facility engineers work smarter.

Andy Foerster, P.E., Square D Company, Smyrna, Tenn.

Imagine that you are evaluating a proposal for feeding a new uninterruptible power supply for your facility's refurbished computer center. Your assistant reported that she thinks two existing substations can handle the load. You turn to the personal computer on your desk, tap a few keys and access trending information that shows one of the substations would be badly overloaded by the uninterruptible power supply during the peak consumption days of August. (Note to yourself: Teach assistant not to make recommendations based on a one-time reading of substation meters).

The phone rings; the Management Information System manager is blaming maintenance for causing a computer crash, but maintenance insists otherwise. A couple more keystrokes show you that the plant took a two-cycle sag from the utility at the time the computers crashed. You print out the waveform of the sag and start to write a memo to the utility's industrial service group.

Before you can finish, a window opens in the middle of your screen warning that the plant is about to set a new demand power peak. You call the production supervisor; yes, he saw it on his computer too, and the system is already shedding non-essential loads.

Meanwhile, accounting has been crediting your budget with funds for the electricity used by other groups and tabulating new cost figures for products based on the electricity consumed in making them. Of course, they have done it from their own personal computer without bothering you at all.

Real technology, real results

If you think you're dreaming, think again. You *can* do these things today, saving your facility substantial amounts of money and making your own workday more efficient and rewarding. The technology that makes it possible is called power monitoring.

Used effectively, power monitoring and control systems cut energy waste and utility penalties, allocate costs, trim overhead and maintenance costs, and reduce downtime.

Electrical costs can be a major expense of doing business. Electrical costs include the monthly utility bill, of course, but they also include costs that usually are overlooked, such as the cost of buying and maintaining electrical distribution equipment and the cost of downtime when electricity fails due to poor power quality or other undetected problems.

These true costs of electricity have been ignored because, until recently, there was no cost-effective way to measure them. But power monitoring and control systems changes that, giving facility engineers the tools to identify and control these hidden costs.

With power monitoring and control systems, an engineer can identify exactly where a facility's power dollars are being spent—and where they're being wasted. A power monitoring and control system warns of overloads or other problems, helping to prevent downtime. It plots trends of plant parameters, allowing maintenance to be anticipated and scheduled. And it tells a facility engineer exactly how much capacity is available at each point in a distribution system, eliminating guesswork about accommodating major plant expansions and capital improvements.

These true costs of electricity have been ignored because, until recently, there was no cost-effective way to measure them.

Getting there

To get the latest electric information from your personal computer, and allow your co-workers to do the same, you need a power monitoring and control system with the following functionality:

Monitoring. The ability to measure plant electric parameters, including amps, volts, power, energy, and other basic measures, as well as more sophisticated readings such as power factor, total harmonic distortion, and circuit breaker position. Display of actual system waveforms is another option that can aid in troubleshooting both harmonic and disturbance power

Ignorance Is Expensive:
How Electric Plant Information Can Save Money

- Find ways to cut utility demand charges.
- Promote energy accountability and conservation.
- Provide information needed to negotiate best possible power agreement with utility for a plant given situation. Take advantage of interruptible demand or peak shaving if available.
- Track energy content/cost of products so that better pricing and marketing decisions can be made.
- Reduce plant down time down time by anticipating overloads or failures.
- Identify problems caused by poor power quality and evaluate solutions.
- Reduce maintenance costs by carefully monitoring equipment performance.
- Reduce capital expenditures by more effectively using existing electric plant equipment.
- Obtain state sales tax rebate for electricity used in production.
- Take advantage of any state enterprise zone concession.

quality problems. Monitoring devices can be either stand-alone circuit monitors or an integral part of circuit breaker trip units, transformer temperature controllers, protective relays, adjustable frequency drives, or other components.

Communications. A means of moving the raw data from the monitoring devices in the field to the personal computers. The communication system must be capable of forwarding data to users over some practical medium. Direct interfaces with other automation systems also is desirable. Inadequate communications can make an otherwise attractive system virtually useless.

Application software. Transforms your personal computer into a user-friendly window on your power system. The software allows your personal computer to collect, sort and translate the data. Then, since getting buried in raw data is the last thing most engineers need, the software organizes, stores, and presents the data in useful ways. Displays may include trend plots, graphic overlays of the plant with current data, bar charts, alarm screens, and other intuitive presentations. A key item to be considered early is whether the graphics can be changed later to reflect, for example, the addition of a new substation. Is capturing those changes easy, or will you need to become a programmer just to keep your system current?

Automatic control (Optional). Added if the information collected is to be used to automatically compensate for problems or carry out money-saving actions. For example, power factor correction, load shedding, emergency load transfer, and demand control are tasks that may be automated.

Evaluating a potential system

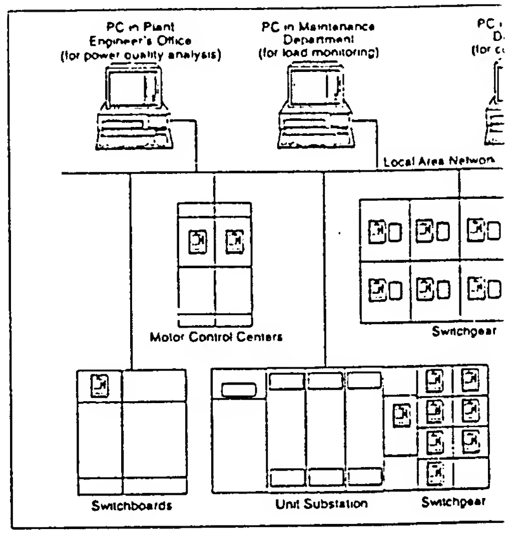
Many choices must be made when selecting a power monitoring system. Following are some considerations that will help you to make an informed decision.

Monitoring devices

Data. Begin by deciding what types of data to collect. Choices include volts, amps, power, energy, power factor, demand values, running min/max values, and harmonic analysis. With modern electronic meters, measuring many parameters costs just a little more than measuring a few.

Accuracy. Decide how accurate each metered value must be. Remember that accuracy is money—a two percent error is $2,000 if a facility has a $100,000 power bill. Also remember that one percent of full scale is actually about five percent of reading at light loads. Ask if power factor affects accuracy or if annual recalibrations are required. Look for a system that uses true RMS sensing to reflect actual heating of conductors and equipment if harmonics are present.

Device options. Determine what options are offered and which best suit your application. A general purpose circuit monitor is fine for almost all applications, but compatible trip units, protective relays, molded case breakers, motor relays and other devices may be less costly options in certain cases.



Power quality analysis. If harmonics or disturbances are an issue, you will want a system that can display waveforms. Ask if the voltage and current waveforms are taken simultaneously so that meaningful comparisons and harmonic flow analysis can be done. Make sure that the waveforms presented are real system waveforms and not synthetic composites. Ask how many samples are taken per cycle. The more samples, the more accurately distorted waveforms can be reproduced.

Logging. Logging is one of the major uses of a power monitoring system, so look carefully at how it is done. Logging may be performed by the individual monitoring devices or by the system software. Each has advantages. Logging at the software allows more flexibility and is more versatile. Logging at the monitor preserves the data in case of a communication failure.

Inputs and outputs. I/O is used to sense the status of external devices, pick up transducer data, or count pulses from older watt-hour meters. To interface or control using I/O, make sure that the correct digital or analog I/O is available.

Communications. Determine whether the monitoring device being considered can communicate with a complete control system. Ask whether additional hardware is required. Is it possible—and convenient—to retrieve internally logged data or perform diagnostics through a temporary connection?

Durability. Monitoring devices should be designed and tested for the environments in which they will be installed. Determine whether the device you're considering can stand up to temperature extremes and other special con-

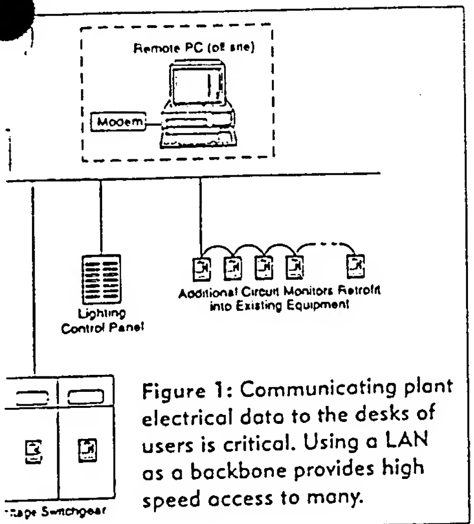


Figure 1: Communicating plant electrical data to the desks of users is critical. Using a LAN as a backbone provides high speed access to many.

ditions in your facility.

Communications

Speed. Power monitoring systems can create a lot of data; one general purpose monitoring device is equivalent to more than 50 analog meters. Disturbance monitoring and waveform capture creates more data. If communications is slow, the system bogs down.

Sharing information. Can multiple personal computers access the same data? The more people who use the information, the more it is worth. Consider whether the maintenance supervisor, electrical shop, plant engineers, accountants, and others will be able to get the information they need simultaneously, when they need it, without interrupting each other.

Programming. Are programmable logic controllers used for communications? Who will program them? Or is the communication system a fairly straightforward matter of connecting cables?

Protocol. Physical protocol relates to the hardware—the wiring and voltages used and other parameters. RS-485 is the industry standard, and it allows the use of off-the-shelf converters and modems; non-standard protocols may require special hardware. Logical protocol is the digital language used, and there is no industry standard. Look, therefore, for a commonly used logical protocol.

Noise immunity. Many industrial settings have significant electrical noise from motors, welding and other equipment. This noise can interfere with the data transmitted by a power monitoring system. Make sure that the communications system was designed to operate reliably in electrically noisy environments and has a proven track record under such conditions.

Flexibility. Can the power monitoring and control system communicate with the facility's pre-existing automation or accounting systems?

Expandability. If remote devices are to be added over time, can the communications network be extended? Will extensive rewiring be required?

Physical medium. Network options include copper cable, fiber optics, telephone modems, line drivers and Ethernet. Does the vendor offer the network type you prefer or may need later?

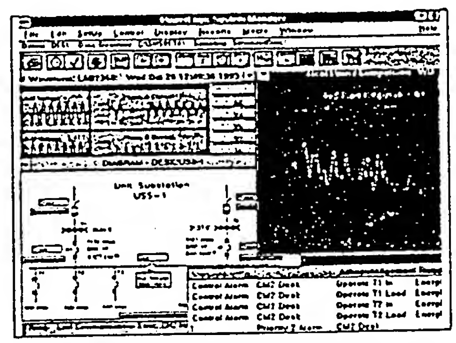


Figure 2: Easy-to-use software runs on your PC. Disturbance waveforms, time trend plots, and graphics of your plant should be just "mouse clicks" away.

Working More Closely With the Electrical Energy Supplier

In the Past	Here and Now
Bill paid by accountant—plant lacked any accurate meter to verify or audit.	Facility engineer can thoroughly verify charges and penalties before forwarding to accountant.
Each bill a "surprise" with only rough data and budget figures for prediction purposes.	Bills can be anticipated almost to the cent as plant production changes are accounted for in real time.
Like taxes, electricity was a cost of doing business. Paid out of overhead.	Each department or product line held accountable for energy used. Greatly increases motivation to find savings.
Production cost of products known roughly.	"Energy content" of each product known with great precision. With better knowledge of costs, more profitable and competitive prices are set.
Only facility engineer—if anyone—knew about energy usage.	Local area networks can provide data directly to those needing access. Personal computers that have access to data in system can be connected wherever needed—accounting, operations, engineering, maintenance.
Only power quantity was an issue. No measure of quality.	Quality of prime importance, as with any other vendor. Especially for facilities with sensitive electronic equipment. Data used to encourage utility to provide quality electrical service.
Little flexibility in negotiating power agreements with utility.	Negotiate as with any other major vendor. Utilities offer attractive incentives to facilities that can control power factor, demand and other parameters. Plant managers have the information they need to select the lowest cost rate structure.

Circuit monitors in the plant, easily retrofit into existing gear, collect electrical data needed for better decisions.

Software

Change. Electrical systems grow and change. If equipment is to be added or moved, can you easily enter the changes to system drawings and files or will you need a programmer or systems integrator to handle the job? Some systems offer software development tools for modifications, but following them can be impossible for all but skilled programmers. Ask whether such software tools are necessary and, if so, whether they are included.

Platform. Will the software run on the IBM-compatible computers normally found in commercial and industrial settings, or does it require a specialized workstation? Can it time-share an existing computer, or will it require a dedicated unit?

Operating system. Ideally, power monitoring and control system software should run on common commercial operating systems already in place in the facility's personal computers. The most common of these are DOS or WINDOWS. If you want to operate your power monitoring and control system from personal computers your company already has, find out what operating system it uses and look for a control systems that can use it as well.

User friendliness. This deals with how easy the system is to learn and to use. Look for systems that have "help" windows and other on-screen prompts that help operators use the program without having to remember complex typed-in codes or refer to bulky manuals.

How much software? Does the vendor offer one easy-to-use package with the functionality desired? Or must you use other spreadsheets, databases, and graphics tools to get the displays and features you want? With the all-in-one approach you do not have to learn to use multiple applications to tend the software "links" that tie the applications together.

Displays. Think about how you currently prefer information to be formatted. Look for a power monitoring and control system that can display information the same way. If you like tables, charts, graphs and plots, a system that can only display columns of numbers will have limited value. Ideally, choices should include one-line drawings, elevations and plan views with real-time data overlaid.

Trending. The ability to display plots of data over time is extremely useful in troubleshooting problems or planning plant upgrades. You will want the ability to plot trends over any time window you specify. Another useful feature is the ability to overlay multiple trends from different monitoring devices on the same plot.

Logging. One of the attractions of power monitoring and control systems is that they can collect and log the same data that, until now, could only be collected by time-consuming manual logging. Determine what logs you need, and verify that the system you are considering can take them.

Alarms. Can the system warn when an electric system parameter is out of specification? Are customized alarm sounds an option?

Passwords. Are multiple levels of security available so that unauthorized personnel cannot tamper with the system?

Conclusion

The exciting potential of power monitoring and control systems to improve productivity, cut costs, and empower facility operations personnel makes them one of the most attractive capital investment opportunities today. Hundreds of facilities around the globe are already using this technology to gain a competitive edge in their markets.

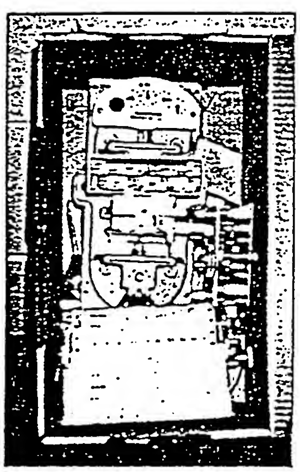
The biggest edge, however, goes to those who have succeeded in finding the system best suited to their special needs. By carefully identifying what they want to accomplish and choosing a power monitoring and control system that can meet those objectives, these facilities have turned their electrical power system from a largely uncontrollable expense into a valuable cost management ally.

Reprinted from PlantServices January 1994

MONITORING SYSTEM UPGRADE MEETS LEGO'S NEEDS

John A. DeDad, Editor-in-Chief

Replacement of old style analog and recording meters with micro-processor-based monitors enables plant engineer to closely monitor power usage of plastic injection-molding operations.



Old style recording meters proved to be maintenance headaches that required paper replacement, ink replenishment, and pen cleaning. Frequent recalibration requirements caused further concern.

MEASURING electrical system parameters on a real-time basis used to require standard analog-type meters with selector switches. In fact, most modern distribution switchboards and switchgear still have these meters as available options. But, remember when recording disk meters were *the* modern monitoring devices? All that was required was that the ink supply be maintained and the recording pens clean and operable. This certainly proved to be not so easy a task.

The main drawback to both types of measuring devices was that electrical facility personnel had to be at the specific equipment location to obtain the needed information. Also, this information was real-time when it was first noted, but became historical the minute the personnel left the location. The lack of any additional information on individual feeder power usage caused further concern.

This basically was the problem faced by John Weber, Director of Building Facilities for LEGO Systems, Inc., Enfield, CT. The system solution, which was discovered during a brainstorming session, proved to be extremely easy to install and utilize. Let's find out how John solved his problems.

Ordering new distribution equipment

LEGO was in the process of increasing its molding capacity and required additional power distribution equipment to power the new molding facility. As a result, the decision was made to install an additional 2000A 480/277V, 3-phase, 4-wire distribution switchboard.

In discussion with LEGO's electrical contractor, the topic of metering options came up. Specifically, the question was posed by the contractor in this fashion: "Do you want the same thing as last time?"

This prompted Weber to recall the problems and limitations of the monitoring devices he was currently using. The most recurring problem centered on his recording meters: they required constant pen and chart maintenance as well as electromechanical recalibration. In fact, they were so delicate the manufacturer refused to return the recalibrated meters through the normal shipping methods. They had to be delivered in a car by a technician. This was clearly undesirable and resulted in a search for a new innovative product. The discovery of a microprocessor-based monitoring system solved Weber's problems.

New monitoring system features

The main metering device is a stand alone type unit mounted directly on the front of the distribution equipment. It has a six-digit LED display and measures voltage (both line-to-line and line-to-neutral), current, kW, kVAR, kVA, power factor, frequency, demand current, and demand power. It also doubles as a Whr and VARhr meter. Cursor key pads allow meter function selection. Some 24 meter values can be read locally at the device.

Aside from all of the above performance characteristics, one particular aspect stood out to Weber. This was the device's ability to communicate, via a 19.2K baud data transmission wiring link, to a remote PC. Now, Weber can monitor a total of 70 meter values on a real-time basis from his office for each of the seven monitored switchboard locations.

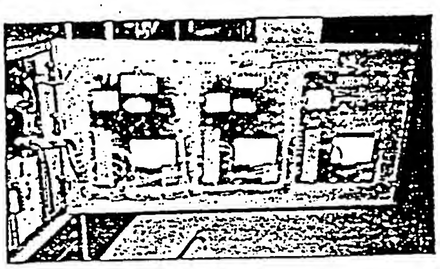
An addition perk is the device's capability of maintaining historical data through its nonvolatile memory, specifically peak current, power, Whr, and VARhr demand. With printouts of this data, Weber is able to accurately budget energy costs by department in lieu of the estimated values previously used.

The devices are true-rms sensing through the 31st harmonic and are equipped to capture waveforms by recording 64 waveform samples per cycle. They also are designed to directly interface with many programs and software. For example, Weber uses the data logging feature for realtime and historical data to monitor a specific switchboard prior to adding additional electrical loads. (Fig. 1)

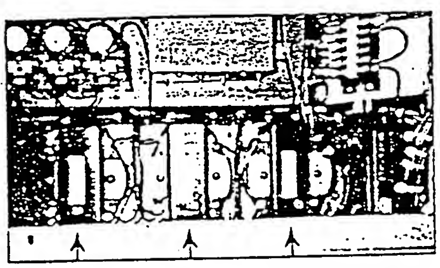
New monitor is mounted on door that previously held glass viewing panel for recording meter. Steel panel was fabricated and installed above the new monitor to compensate for its shorter height. Existing terminal strips for CT and PT input connections are reused in existing flush mounted enclosure that previously held recording meter.

Date/ Time	Amps (A) Amps (B) Amps (C)	Volts (AB) Volts (BC) Volts (CA)	PF (A) PF (B) PF(C)	kW kVAr kVA	Ad (A) Ad (B) Ad(C)	Arms kWd kWp	Watthours Varhours
5/11/92	493.1	467	−0.68	301	471.3	550.4	49,506,971
10:53 a.m.	520.2	468	−0.74	−283	487.6	278.0	49,422,995
	525.4	467.	−0.76	412	487.9	378.0	
5/11/92	517.1	467	−0.69	312	471.9	568.7	49,510,461
10:54 a.m.	536.0	467	−0.73	−293	488.6	278.0	49,426,482
	538.0	467	−0.76	427	488.6	378.0	
5/11/92	446.3	468	−0.62	251	473.6	495.3	49,515,232
10:55 a.m.	463.6	468	−0.68	−271	490.5	278.0	49,431,154
	463.7	469	−0.73	368	490.7	378.0	
5/11/92	464.6	469	−0.64	271	474.5	512.3	49,519,961
10:56 a.m.	485.8	468	−0.72	−274	491.4	279.0	49,435,789
	479.9	469	−0.74	384	492.1	378.0	
5/11/92	472.3	469	−0.66	277	476.0	513.6	49,524,781
10:57 a.m.	482.6	468	−0.72	−272	493.0	280.0	49,440,442
	486.4	469	−0.75	387	493.9	378.0	

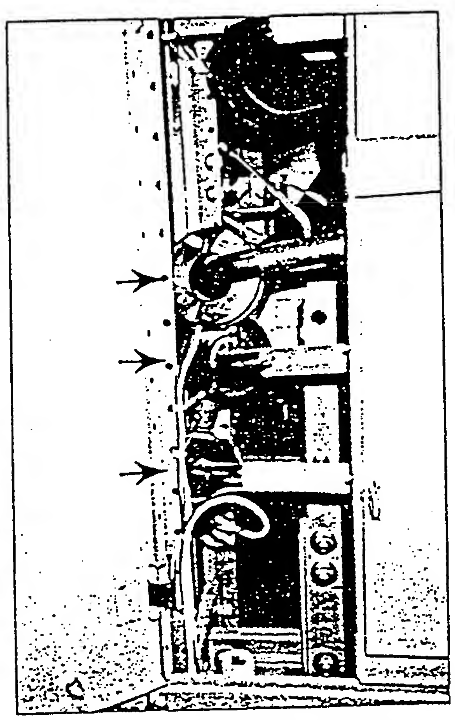
Fig. 1. Sample printout details performance of a molding hall power feeder. The data are stored in the monitoring system for recall through its nonvolatile memory.



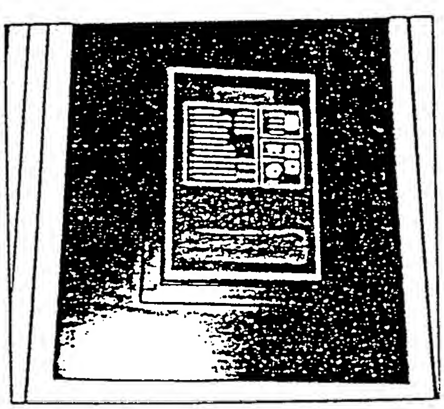
Rear view of three molding hall power feeder monitors shows input connections for CTs and PTs, along with shielded twisted pair cables, running to terminal strips just inside existing switchgear.



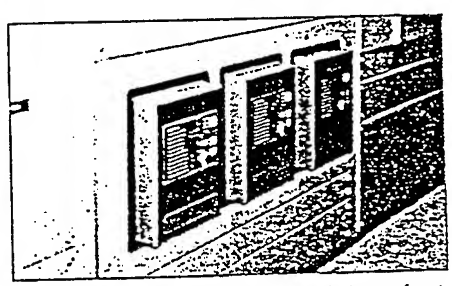
Three existing PTs (arrows) were replaced with identically-mounted units with different ratios.



Three CTs (arrows) were installed on the load side phase conductors for one of the molding hall power monitors.



Front of existing panel has new monitor installed in faceplate, with painted sheetmetal panel installed above it.



Three new monitors are installed in lower front panel of existing switchgear and monitor three molding hall feeders. Panel front was measured and cut to accept monitors. Feeder overcurrent protective devices (OCPDs) are located above and to the right of the monitors.

What about the existing switchgear?

The obvious question was how Weber could incorporate this new device into the existing electrical distribution equipment on site. Getting rid of the three existing recording meters and the analog meters with phase tap switches was high on Weber's priority list.

The existing recording meters were housed in flush enclosures with hinged doors, which in turn were mounted on hinged front panels on the existing gear. The enclosure doors had glass panels so that the recording meters could be viewed.

When Weber and his men removed one of the recording meters from its enclosure, they found there was more than adequate space for the new monitor and its wiring harness, and that the existing terminal strips could be reused. They also found that the width of the opening for the glass panels matched exactly that of the new monitor. All that was required was to fabricate a painted steel plate to cover the remaining part of the opening, since the new monitor was shorter than the original glass panel.

The current transformers (CTs) from the existing recording meters were able to be reused without modification. Potential transformers (PTs) were added or replaced as needed. Several of the existing PTs were replaced with identically-mounted units having different ratios to match the monitor's specs.

Feeder monitoring

Now that Weber and his men were knowledgeable in installing the new monitors, their attention was moved to the various feeders. Weber wondered how difficult it would be to monitor existing molding hall feeders. He found that additional monitoring devices could be installed just as easy.

In one piece of existing switchgear, three separate molding hall feeders were to be monitored. An inspection of this gear found a lower hinged front panel that was blank. This panel was then cut to accept three new monitors and terminal strips were placed just inside this panel.

A hinged vertical side door mounted next to the feeder overcurrent protective devices opened to reveal the load side conductors and the newly installed CTs of one of the monitored feeders. The existing PTs from the main service section were large enough to supply the main switch monitor as well as the three additional subfeed monitors located on the same bus. Their burden and supply requirements were insignificant compared to that of the old electromechanical meters.

Each monitoring device has an integral terminal strip for 3-phase voltage and current inputs direct from PTs and CTs mounted within the monitored gear. Also included is a terminal strip for the shielded twisted pair communications cables used for the 19.2K baud signal. The monitors are daisy chained using the shielded cable, which is run in EMT between the new and existing gear. A 120V control power input is derived from within each respective piece of switchgear, or fed from a properly sized PT.

DESCRIPTIVE BULLETIN

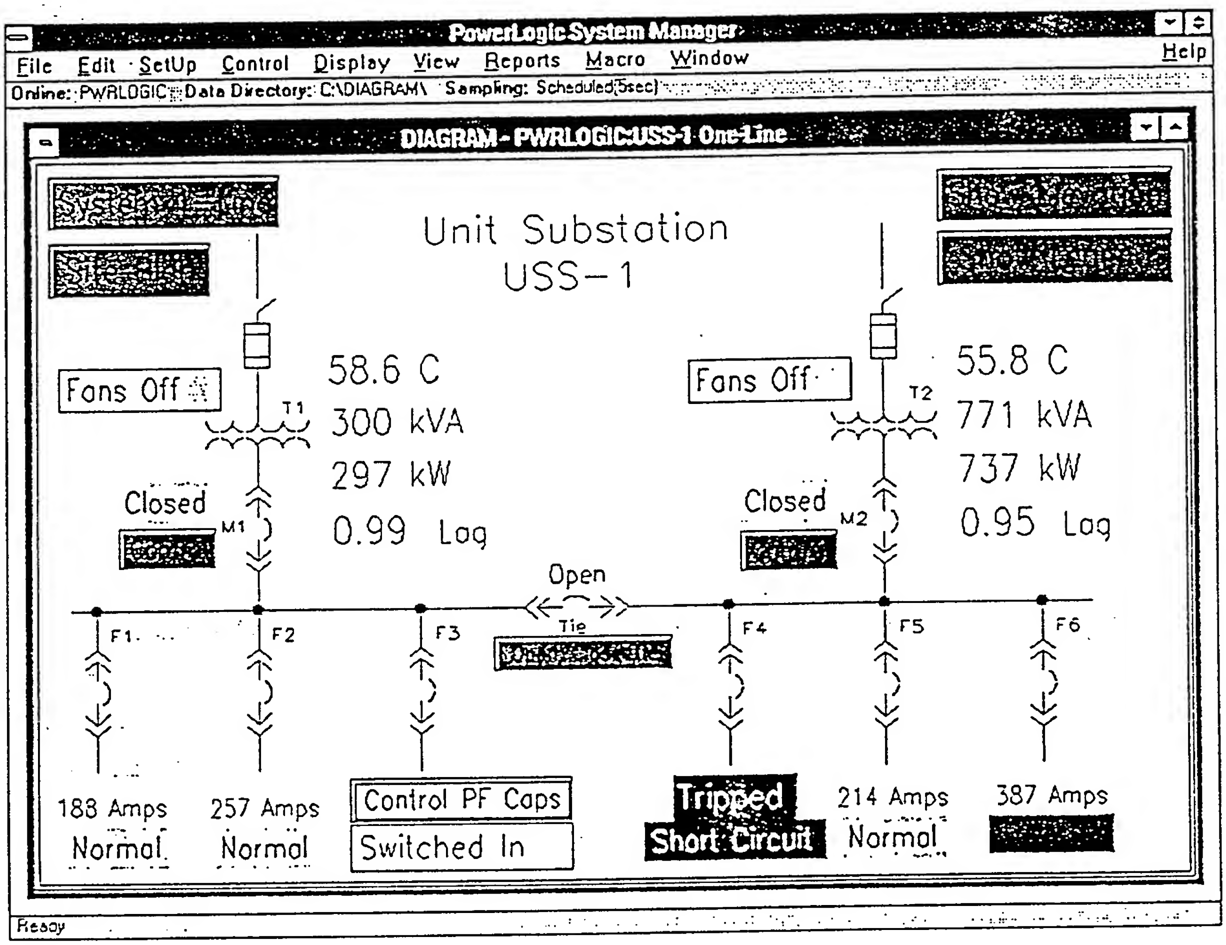
Bulletin DB-109

May, 1991

PowerLogic®

Interactive Graphics Interface

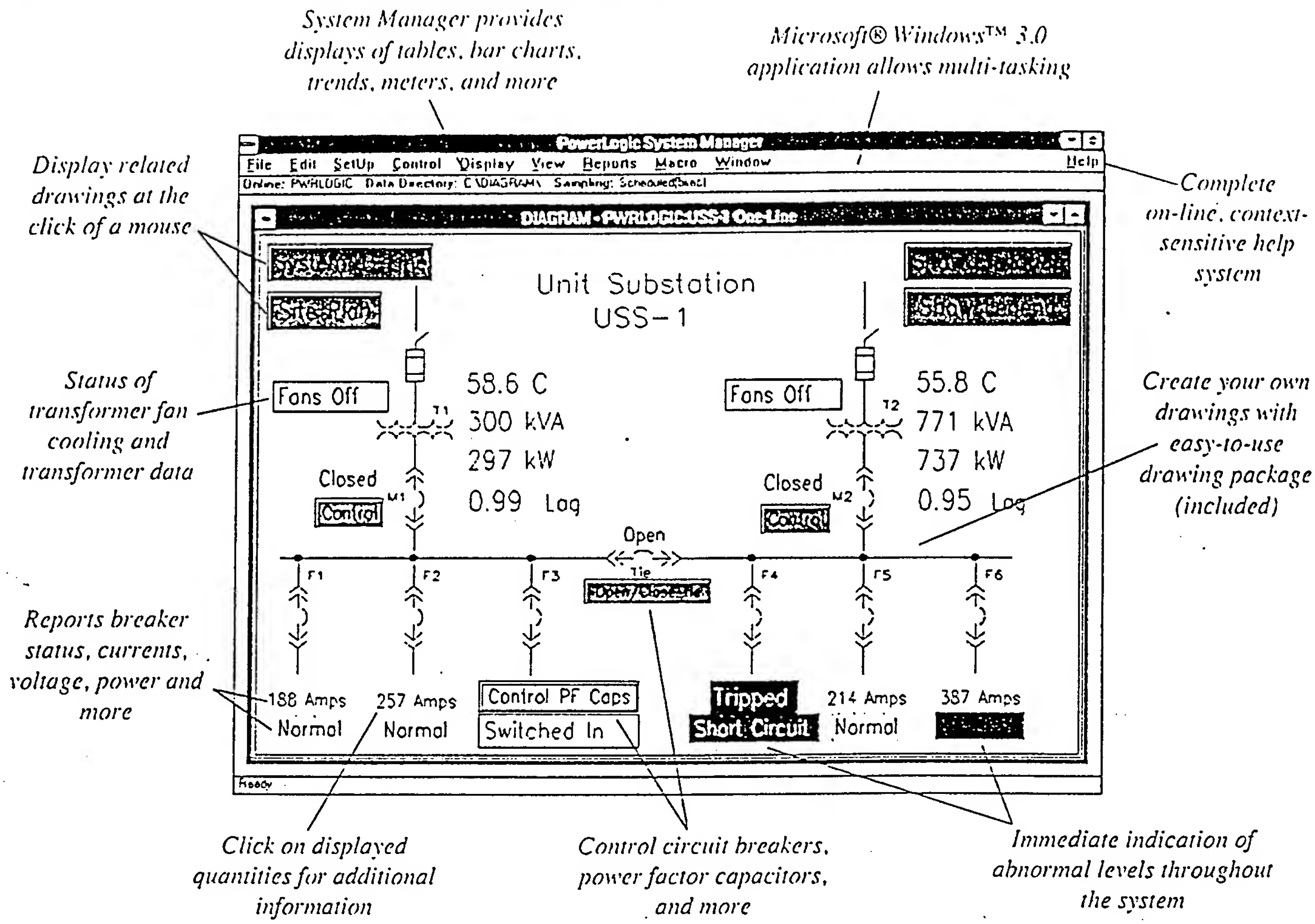
for System Manager™ and System Manager Plus™ Software



SQUARE D

We Respond.

Interactive Graphics Interface



What is the Interactive Graphics Interface?

The PowerLogic® Interactive Graphics Interface (GFX) is a color graphics software application which displays system-wide information on a personal computer. GFX is an Add-On program which works in conjunction with the PowerLogic System Manager™ or System Manager Plus™ software. (An Add-On provides additional capability to a larger program but cannot be run independently).

GFX displays real-time information directly on a drawing such as a complete system one-line diagram, switchgear elevation drawing, site plan, or plant or equipment room layout.

Like each of the System Manager programs, GFX utilizes the Microsoft® Windows™ 3.0 graphical environment. The Windows environment provides easy point-and-click operation and allows users to run other Windows applications while data logging and alarms continue in the background. The GFX package includes an easy-to-use Windows 3.0 compatible drawing package to allow the user to create and modify custom drawings as needed.

GFX can display real-time data from PowerLogic Circuit Monitors, SY/MAX® programmable controllers, Model 85 temperature controllers, Micrologic® Trip Units and other compatible devices. Single drawings can be displayed by simple menu selections, or nested within other drawings to provide hierarchical access.

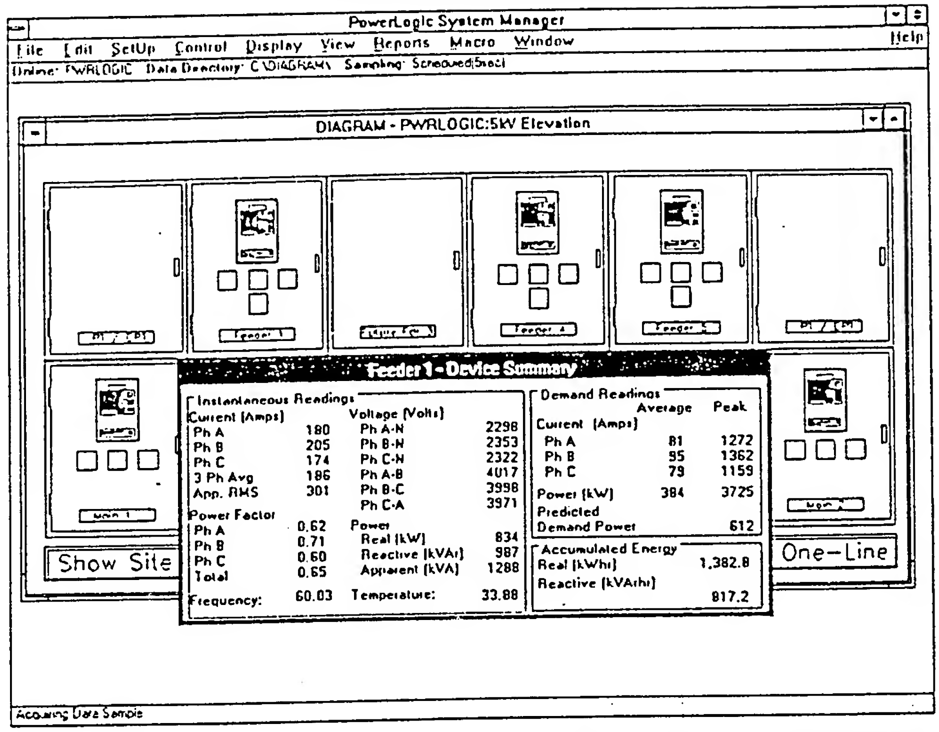
When coupled with the System Manager Plus software, GFX can be used to perform interactive control operations such as breaker control, load shedding, and so on.

Flexible Display of System Data

All types of real-time system data can be displayed on the drawings. Data displays are divided into several categories referred to as "Data Blocks." These include Value Blocks, Analog Function Blocks, Digital Function Blocks, Hyper Drawing Blocks, and Control Output Blocks. GFX provides you with complete flexibility to select the type, size, location, units, and color of each Data Block.

Value Blocks Display Real-Time Data

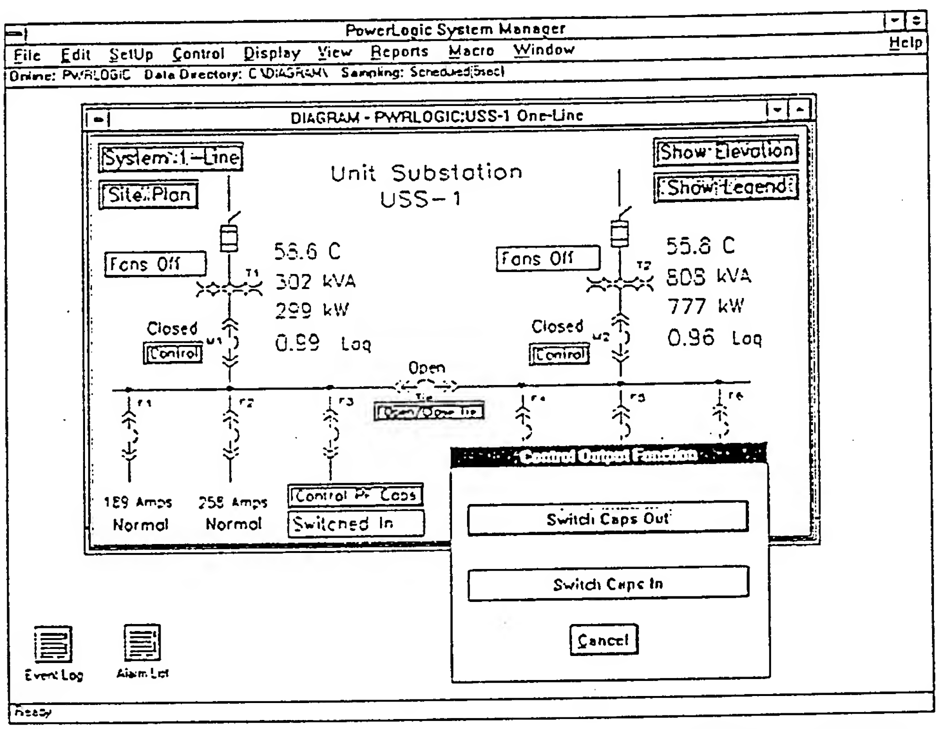
Value Blocks display real-time data for a single value. A Value Block can display any electrical quantity provided by PowerLogic Circuit Monitors such as instantaneous quantities, energy readings, and demand readings. A Value Block can also display the contents of a register in a SY/MAX controller or compatible device. In addition, each Value Block can be assigned a user-defined text string which identifies the value being displayed.



Double-click on a Value Block to invoke a device summary showing a complete set of instantaneous, demand, and accumulated energy values.

Device Summary Provides Comprehensive Information

Value Blocks provide additional information in the form of a "Device Summary". A Device Summary provides a concise listing of additional device-specific quantities. For example, double-clicking on a Value Block for a PowerLogic Circuit Monitor invokes a Device Summary containing instantaneous quantities, energy readings, and demand readings.



Control power factor capacitors, open and close breakers, turn fans on and off, and perform other control operations, directly from your diagram.

Control Output Relays Using Control Output Blocks

Control Output Blocks give you the capability to operate Circuit Monitor output relays or modify the contents of other compatible device registers. (System Manager Plus required for output control). To perform a control operation you simply double-click on a Control Output Block and enter the appropriate password. As added assurance, GFX issues a confirmation box (pop-up window) that states the action about to occur, and gives you the opportunity to cancel the operation.

Interactive Graphics Interface

Report Breaker Status Using Digital Function Blocks

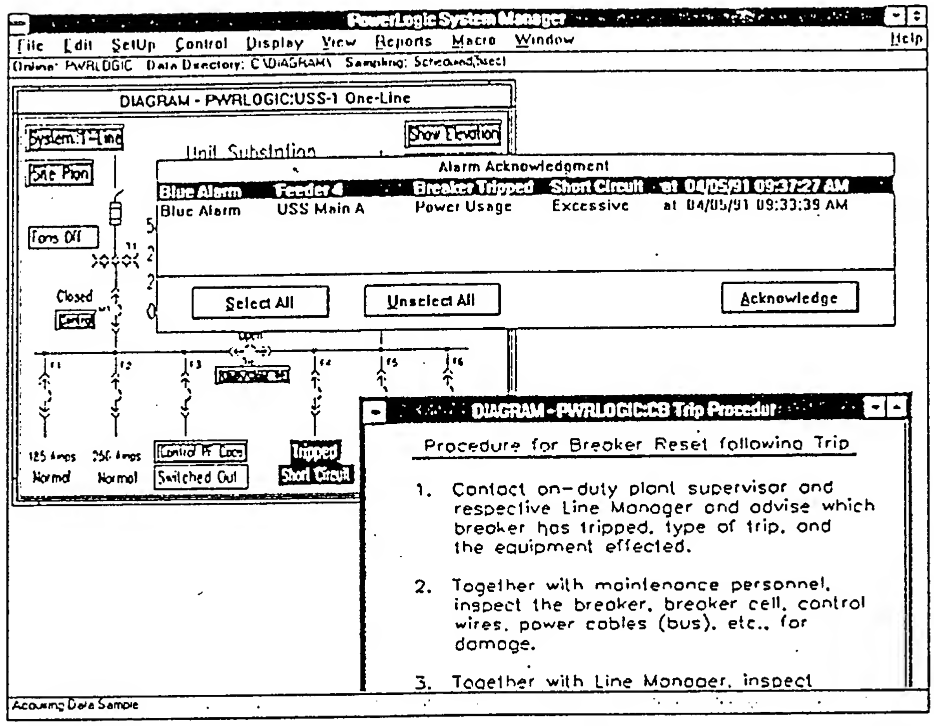
Digital Function Blocks display the real-time condition (state) of a discrete contact/relay in the system. For example, breaker status and transformer fan status can be displayed on the drawing. And GFX allows you to assign a specific color to a given condition. For example, the "Closed" condition of a circuit breaker could be color-coded as red, while an "Open" condition could be color-coded as green. This allows you to quickly determine the status of critical loads throughout the system based on the colors selected.

View Equipment Usage Levels Using Analog Function Blocks

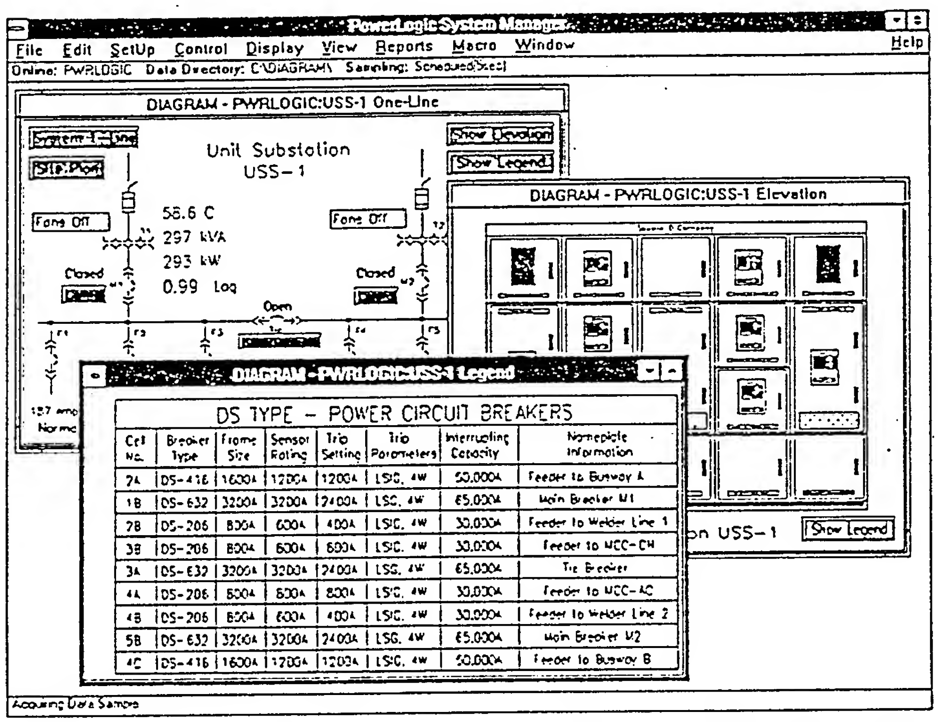
Analog Function Blocks display the real-time condition (state) of an analog quantity, such as load current, demand power, etc. GFX allows you to assign specific colors to a given condition. For example, an "Overload Pending" condition of a feeder breaker could be color-coded as yellow, and a "Normal" condition could be color-coded as blue. This allows you to quickly determine the status of critical loads throughout the system based on the colors selected.

Display Related Drawings Using Hyper Drawing Blocks

Hyper Drawing Blocks provide hierarchical access to related drawings. Simply double-click on the Hyper Drawing Block and the linked drawing appears. For example, a drawing containing a campus of buildings might contain a Hyper Drawing Block for each building. You could then double-click on a Hyper Drawing Block causing a window to appear showing a one-line diagram for that building. Each drawing can contain as many Hyper Drawing Blocks as necessary.



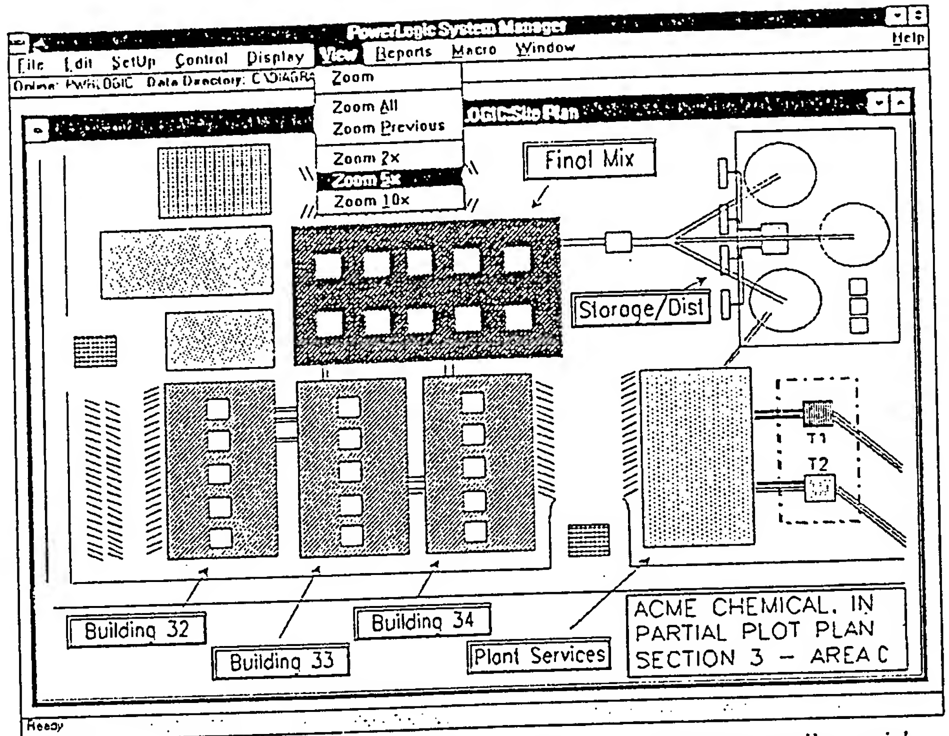
The powerful combination of System Manager and GFX provides multi-level alarms and the ability to develop custom follow-up procedures for system events.



Display one-line diagrams, elevations, legends, or other system information, and tie them together using hyper drawing blocks.

Zoom, Scale and Scroll

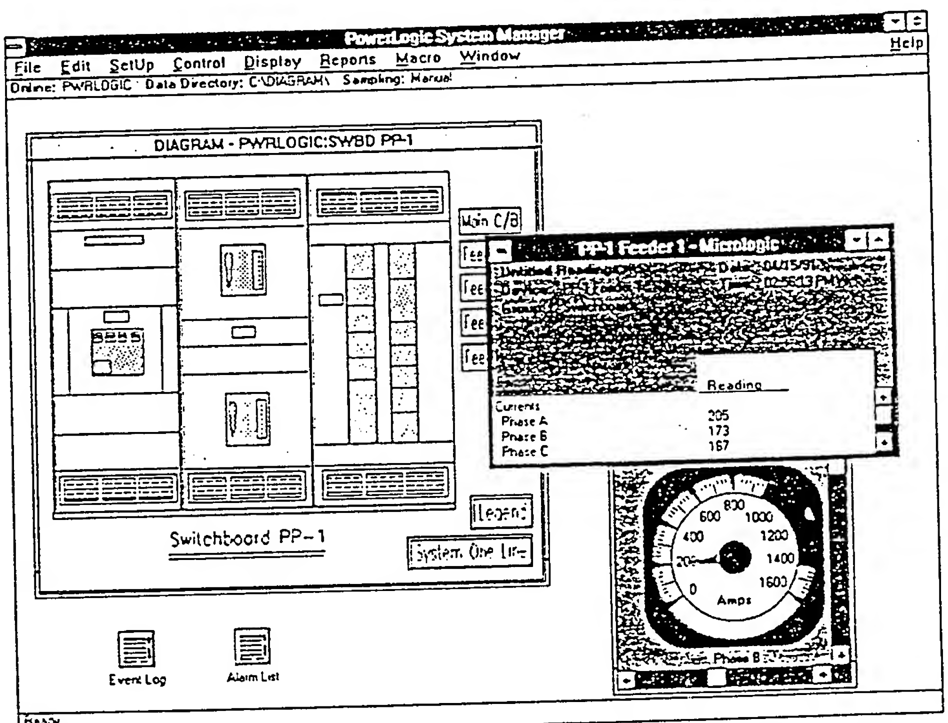
Each drawing can be scaled and viewed at varying degrees of magnification. You can Zoom in on a specific area, return to the previous level of magnification, or view the entire drawing. Magnified drawings include vertical and horizontal scroll bars which allow you to pan throughout the drawing to reach a desired location.



Display entire plant layouts, site plans, or campus arrangements to allow quick access to any location in the system.

A Variety of Electrical Symbols Included

A variety of electrical symbols is included with GFX to reduce drawing development and maintenance. Symbols provided include transformers, circuit breakers, switches, and many others. Additional symbols may be created by the user and stored in a library.



Data from compatible devices, such as Micrologic® circuit breakers, can be displayed in a variety of formats.

On-line Help System and User's Manual

GFX provides easy-to-follow help through its On-Line Help System and User's Manual. During setup or program operation, you can select help on specific topics from the help index and receive context-sensitive help on the present command via special function-key operations. A printed User's Manual is also provided. The On-Line Help System and the User's Manual work together to provide comprehensive information on program operation.

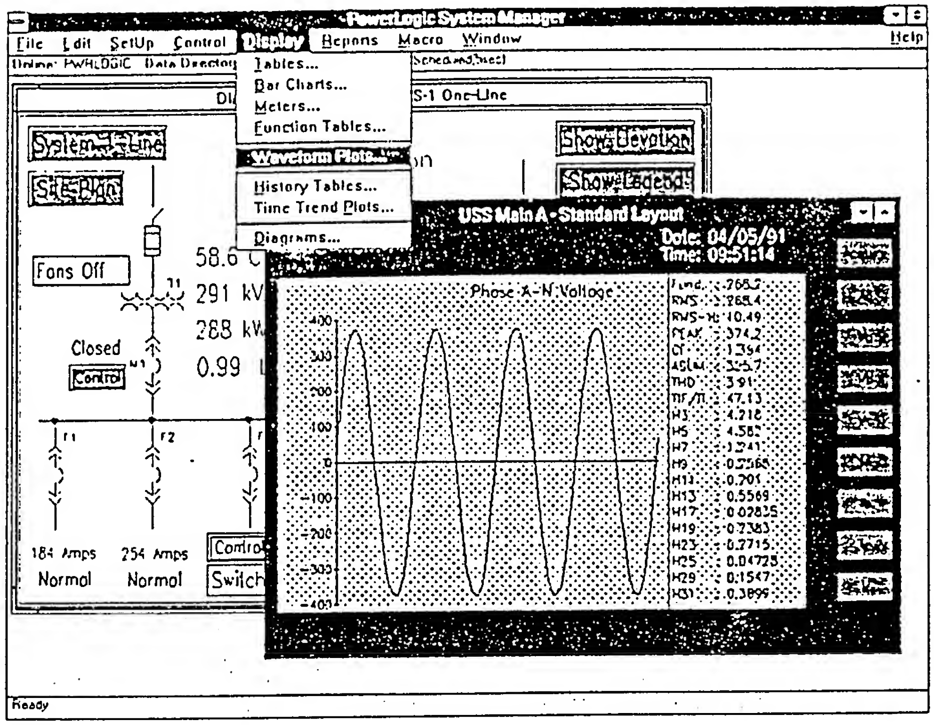
Interactive Graphics Interface

Create and Maintain Drawings

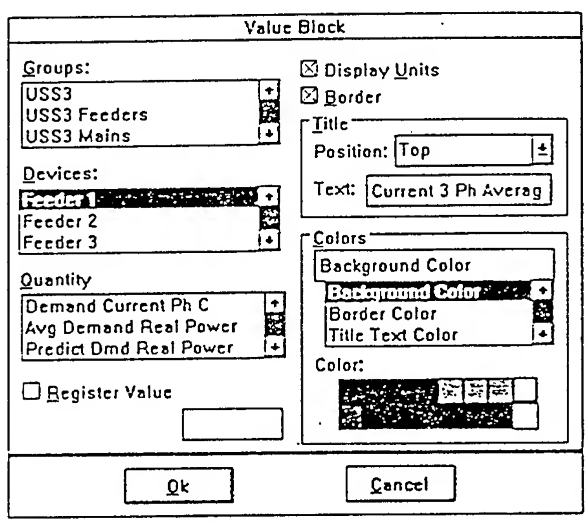
The PowerLogic® Interactive Graphics Interface comes with a vector-based Windows 3.0 drawing package for creating and maintaining drawings. Each drawing forms a background on which data is displayed. GFX allows you to position and size the data anywhere on the drawing using the mouse. Also, colors can be specified for each data item, allowing you to establish your own color code legend. Modification of the drawing is conditional on proper password entry. In this manner, drawings can be easily modified to reflect system changes, additional equipment, etc., without the need for programming or extensive software training.

PowerLogic Application Engineering Services

For new or retrofit power monitoring and control applications, PowerLogic Application Engineering can provide extensive customer assistance. Installation and start-up of PowerLogic Systems including PowerLogic Workstations, Circuit Monitors, software, hardware, and training can be tailored to meet individual requirements.



Data can be displayed on a GFX diagram or in other display formats including bar charts, time trend plots, tables, meters, and waveform plots for harmonic monitoring.



Dialog boxes, such as this one, allow you to customize each data block.

Ordering Information

Class 3080	Type GFX-700	Interactive Graphics Interface

For Further Information - Contact your nearby Square D sales office or call or write to:
Square D Company • PowerLogic • 330 Weakley Rd • Smyrna, TN 37167 • Ph (615) 459-8500

DESCRIPTIVE BULLETIN

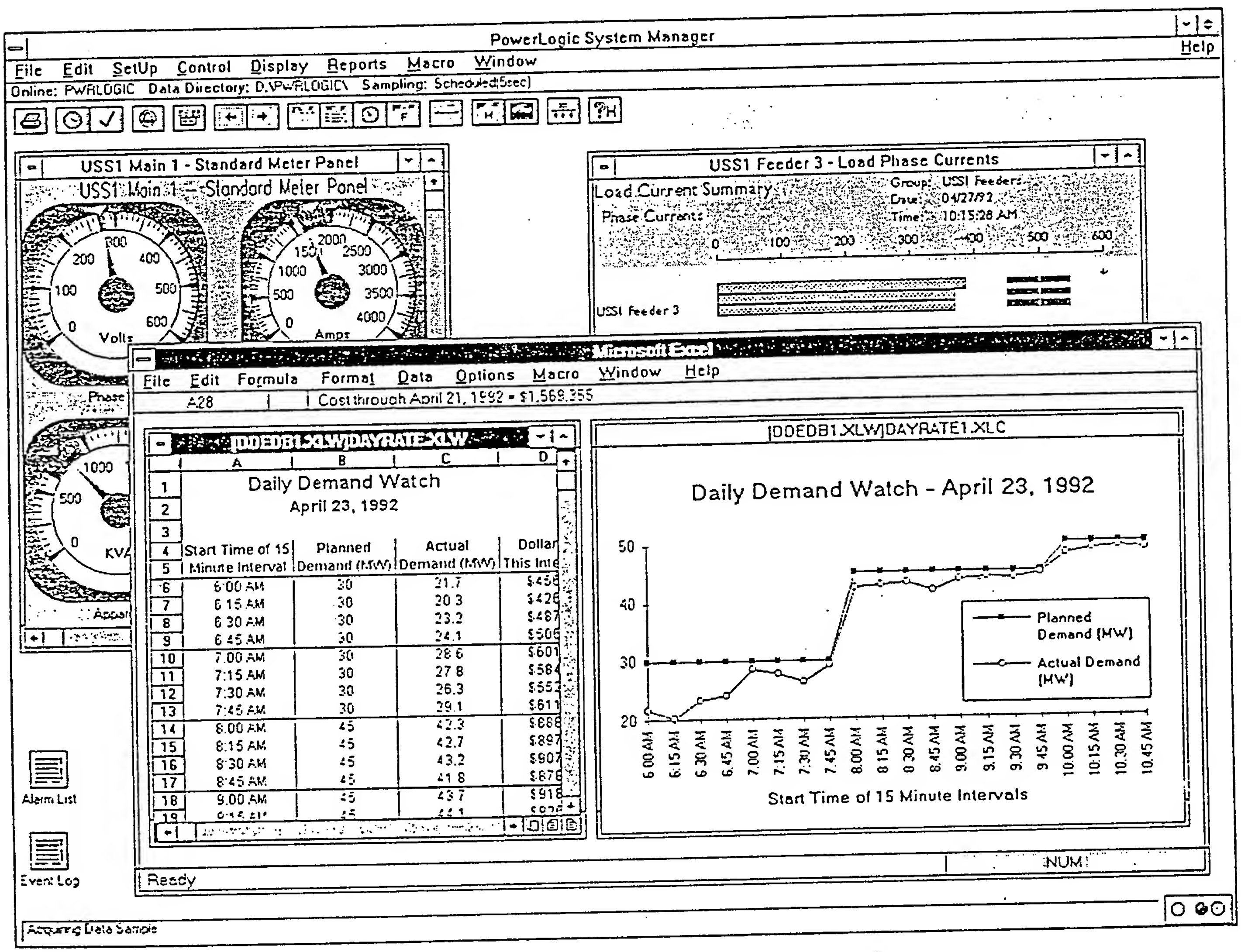
September, 1992

3080SM9204

PowerLogic®

Dynamic Data Exchange (DDE) Module for System Manager™ and EXPlorer™

(Class 3080 Type DDE-300)



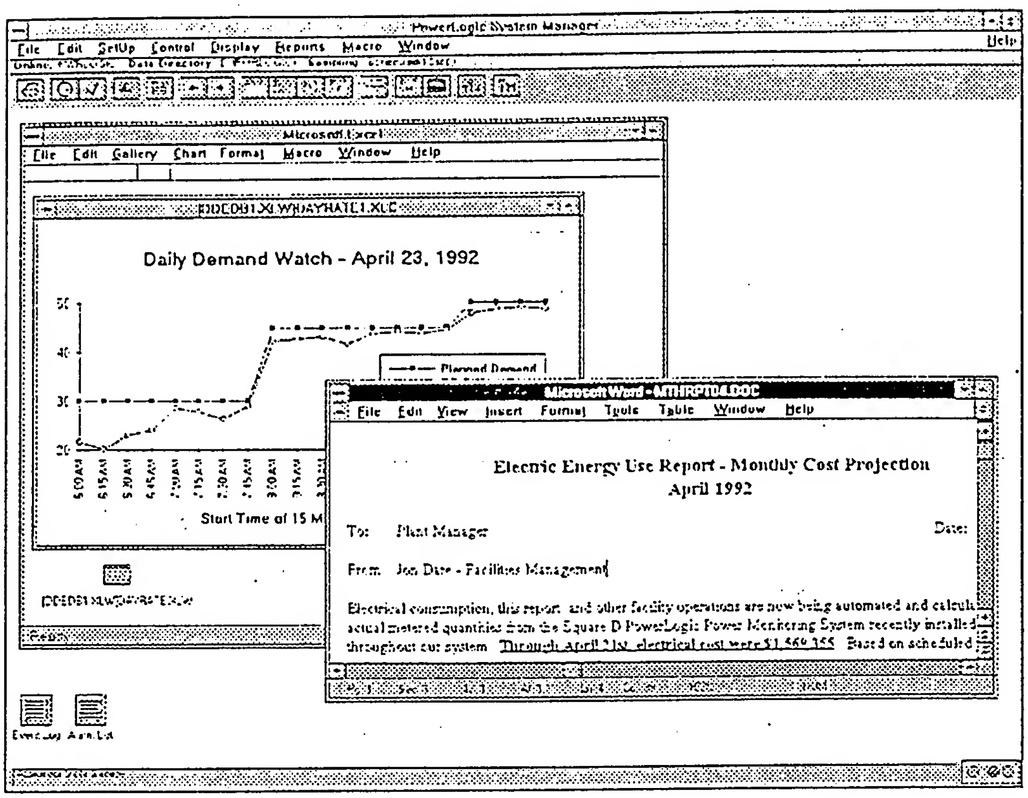
SQUARE D

POWERLOGIC DDE Module

Share system information with other windows applications

Monitor for alarms and events in the background

Simplifies reporting and cost analysis



Works with System Manager & EXPlorer software applications

Create custom reports, spreadsheets, graphics and more

The POWERLOGIC® Dynamic Data Exchange (DDE) Module is a Microsoft® Windows application that allows POWERLOGIC® system information to be dynamically shared with other Windows-based applications. Real-time information from POWERLOGIC Circuit Monitors, MICROLOGIC® circuit breakers, SY/MAX® programmable logic controllers (PLC's), and other POWERLOGIC-compatible devices can be easily integrated into a wide variety of Windows applications.

Many of these Windows applications offer complex reporting with integrated graphics functions and analytical and statistical capabilities—all of which enable comprehensive cost analysis. Some Windows applications even allow you to develop custom applications with user-specific interfaces. The POWERLOGIC DDE Module provides real-time access to the information you need in the applications you choose.

The POWERLOGIC DDE Module is an optional add-on module that works with all POWERLOGIC "core" application software products. Each product is a powerful Windows-based application providing comprehensive power system monitoring and control, while forming the basis for add-on modules such as the POWERLOGIC DDE Module.

<u>POWERLOGIC Core Application Software Products include:</u>

- EXPlorer™ (EXP-500)
- EXPlorer II™ (EXP-550)
- System Manager™ (SMS-700)
- System Manager Plus™ (SMS-770)

Sharing Information Using the DDE Module

- Access information from Circuit Monitors, MICROLOGIC circuit breakers, Lifegard Model-85 Transformer Temperature Controllers, and SY/MAX Programmable Controllers.

- Measure energy use by department, process, and so on, and include it in the total production cost.

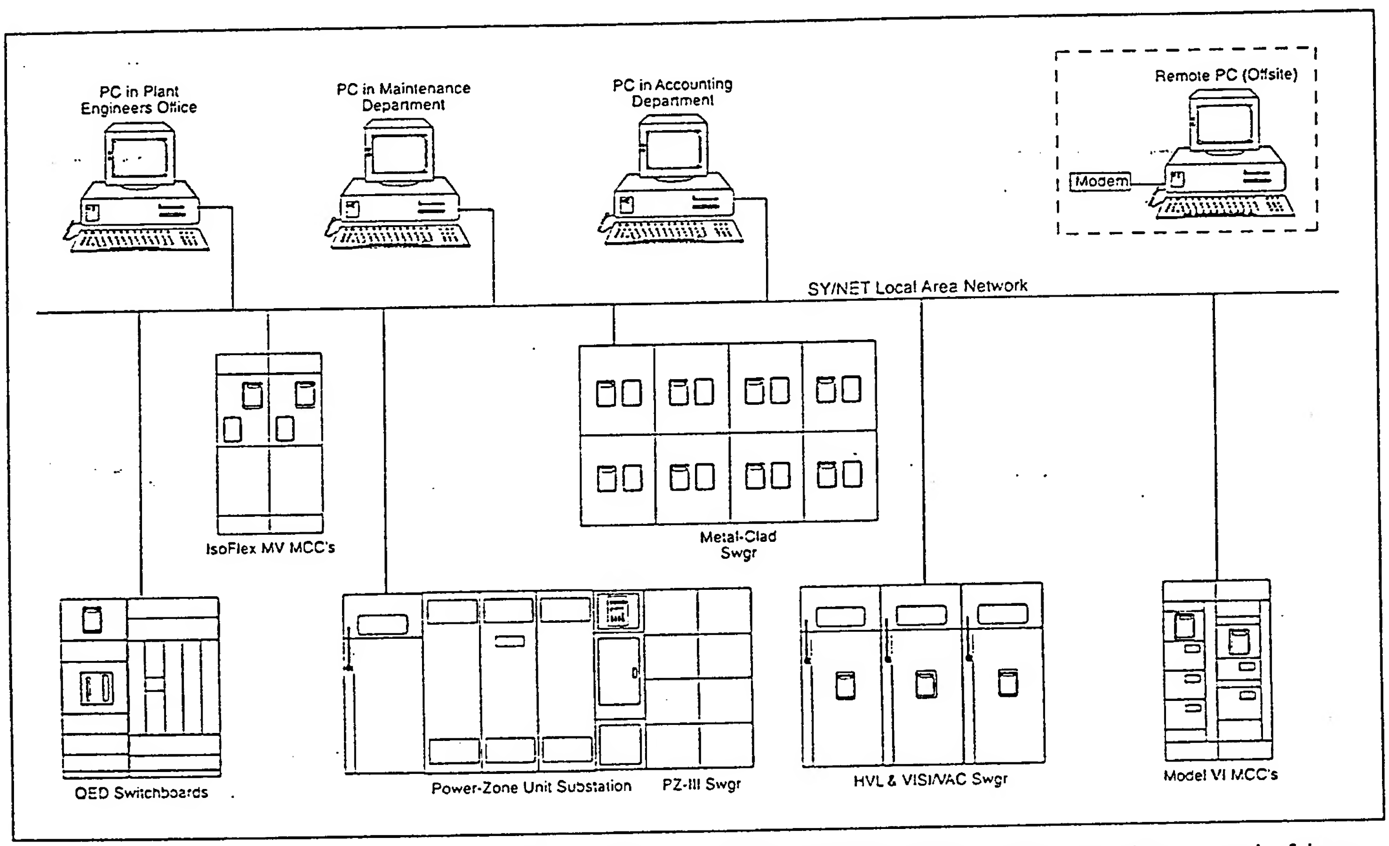
- Create custom reports, spreadsheets, and databases that fit your exact application needs.

- Centralize POWERLOGIC information with information from other systems in your facility—building automation and process control systems, for example.

- Design custom interfaces that incorporate menus, macros, and displays.

- Provide network clients information on a Local Area Network (LAN) [requires additional LAN software].

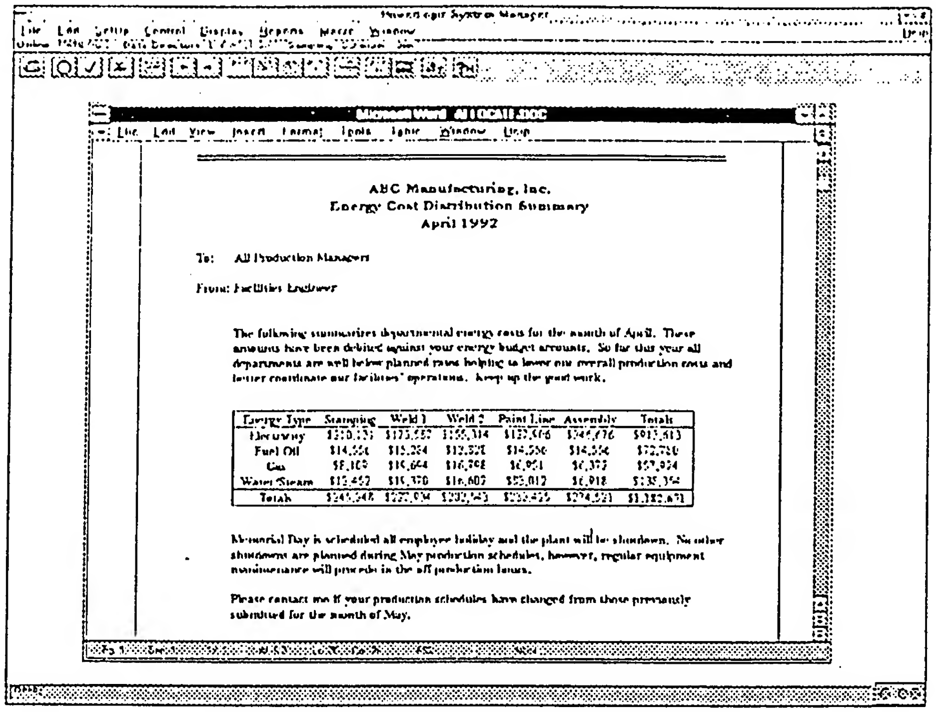
- Establish production costs for specific parts, processes, and operations.



Each computer on a communications network can be equipped with POWERLOGIC software, customized to fit the exact needs of the user.

Analyze Energy Use and Other Patterns

Monitoring where, when, and how much energy is being consumed is an important aspect of power system management. With this information in hand, plant and facility engineers can make informed decisions about system operations. Monitoring energy use throughout the system helps simplify overall energy management since it enables you to receive immediate feedback on the results of your changes.



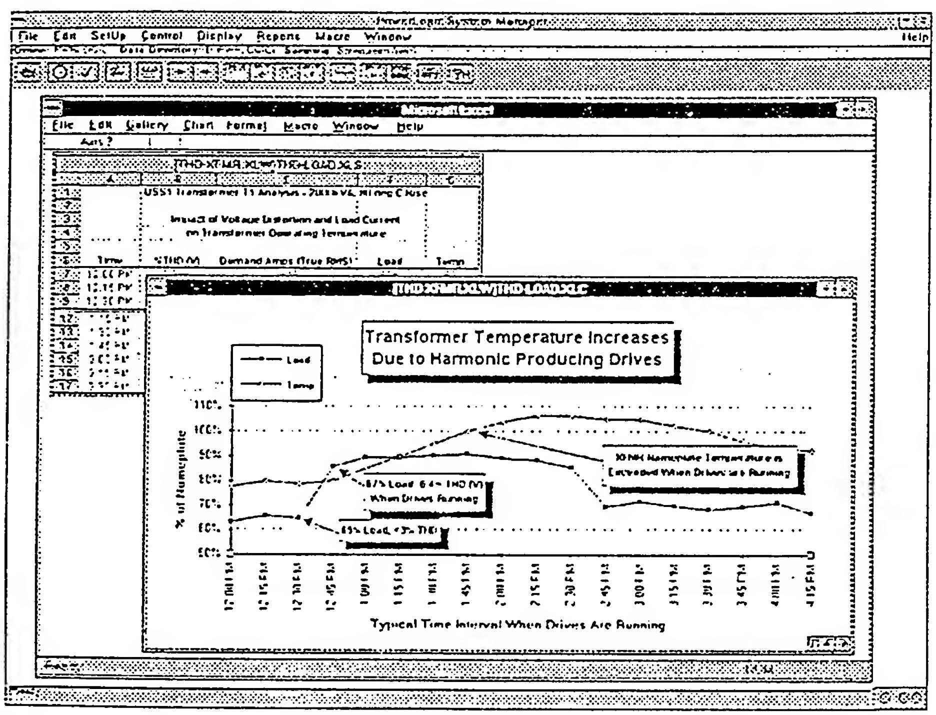
Allocate costs by department, process, or other criteria.

Allocate Costs and Avoid Peak Demands

The POWERLOGIC DDE Module, together with your choice of Windows applications, makes analyzing and distributing energy costs among departments easy. By integrating data directly into a spreadsheet, and graphing information such as demand power against planned usage, you can avoid setting new demand levels.

Analyze Harmonic Impact on Equipment

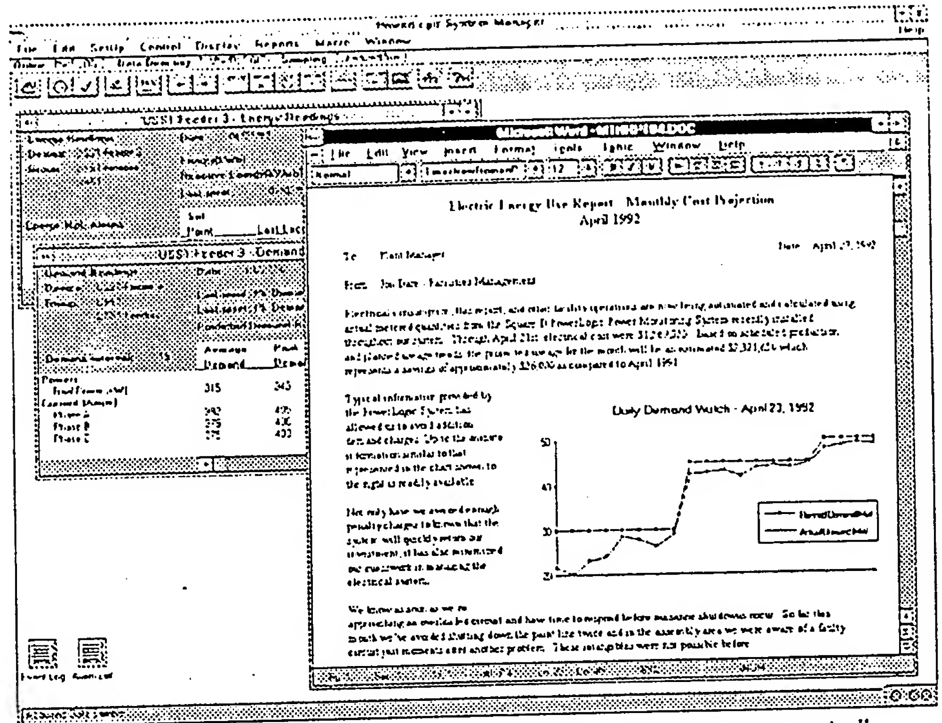
To help address increasing power quality concerns in electrical systems, POWERLOGIC Circuit Monitors can be optionally equipped with a waveform capture feature. Circuit Monitors can capture waveform data and transfer it to the computer, where the System Manager and EXPlorer software can calculate the harmonic content of the waveform. Then, using the DDE Module and a spreadsheet application, you can combine harmonic data with other collected data to analyze harmonic loading versus demand current over time—or perhaps another quantity. This lets you periodically examine the effects of harmonics on various pieces of equipment to identify harmonic levels and determine whether further analysis is required.



Analyze harmonic impact on equipment.

Customize and Automate Reports

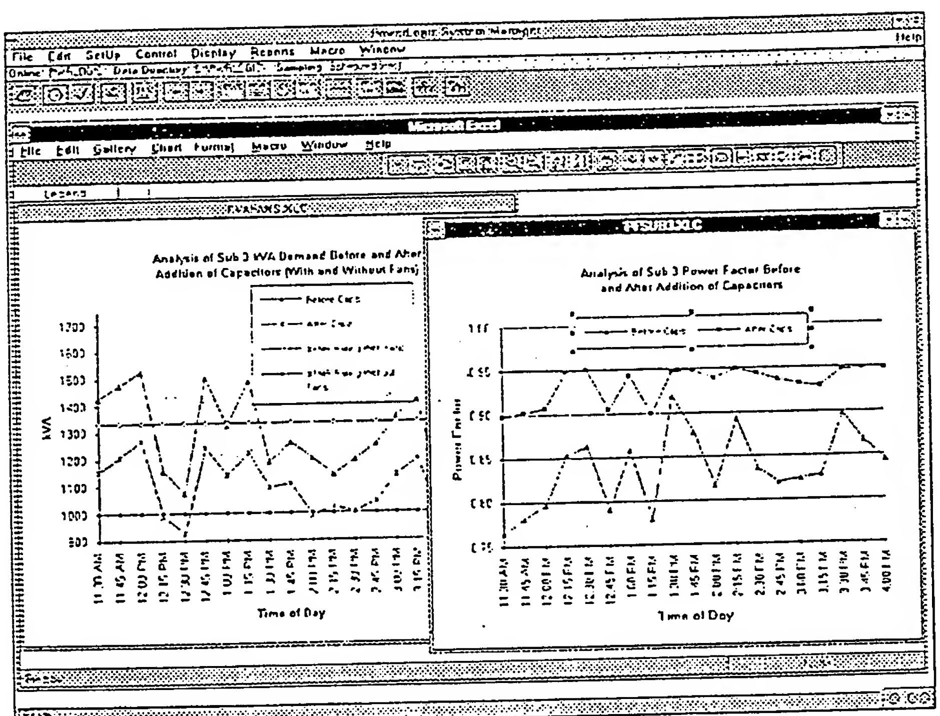
Using the DDE module, you can compile the information you need and generate reports on a monthly, weekly, and yearly basis. The DDE module gives you the freedom to integrate real-time data into your Windows word processing software so you can you take advantage of the powerful capabilities of both products. Reports on energy use, demand avoidance, system maintenance, or facility operations can be centralized in the Windows environment.



Integrate data into a word processing program and generate reports automatically.

Develop Custom Displays or an Entire Interface

Though POWERLOGIC System Manager and EXPlorer products provide a variety of tabular and graphical displays, you can use the Windows application(s) of your choice to develop custom menus, macros, displays, and more. POWERLOGIC's DDE Module provides the information that your Windows application needs to develop a custom display or an entire interface that meets your specific requirements. From simple data logging to a database, to powerful graphical interfaces complete with complex charting and reporting functions—a wide variety of Windows applications are available that allow you to customize your system to meet your exact needs.



Anticipate the effects of equipment changes, and avoid unnecessary expenditures.

Data Sharing is Transparent

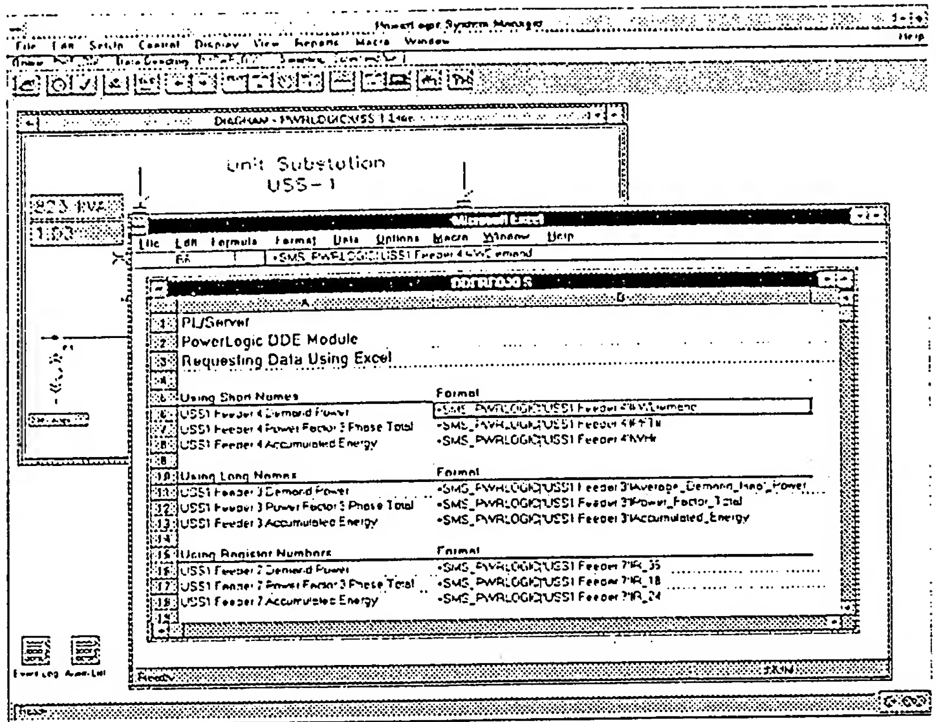
The DDE Module performs all data exchanges as background tasks. This eliminates interruptions to System Manager and EXPlorer functions such as data logging, and monitoring for alarm conditions and system events.

Data Sharing is Simple

The POWERLOGIC DDE Module uses standard DDE protocol as defined by Microsoft Corporation to ensure compatibility with the wide variety of Windows applications. Requesting information from devices in the system is simply a matter of listing the system, device, and quantities you want. This makes the integration of data from Circuit Monitors, SY/MAX PLC's and other POWERLOGIC-compatible devices flexible and easy.

Integrate Process Information

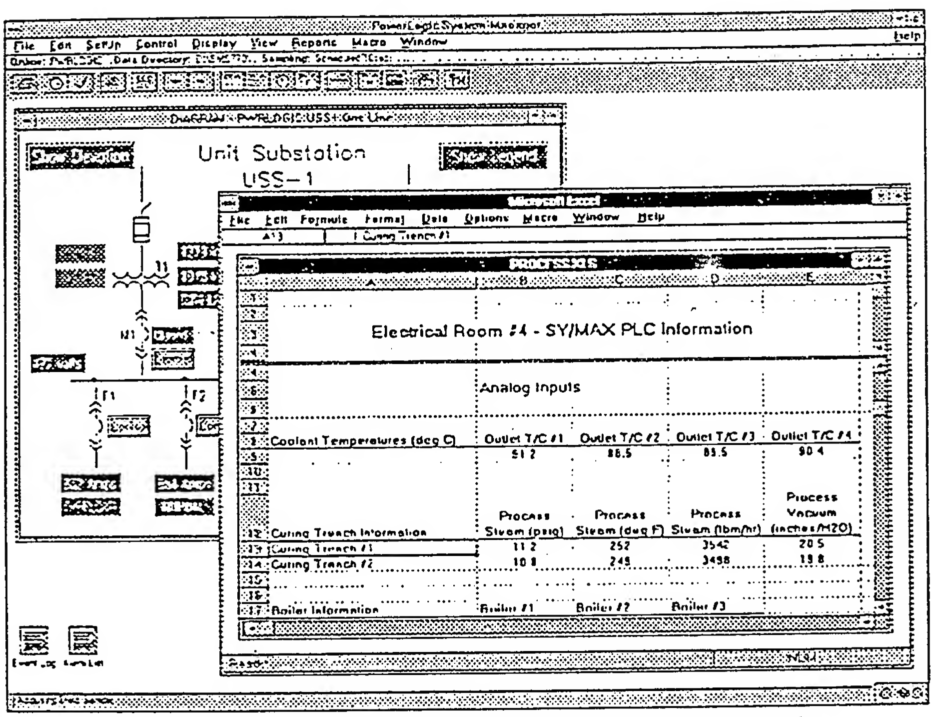
The DDE Module lets you integrate data from Square D SY/MAX PLC's, and selectively place that data into a Windows application. This lets you centralize electrical system data and critical process control information into a spreadsheet, chart, report, or other type of display.



The DDE module uses standard Microsoft Windows DDE protocol to ensure compatibility.

Integrate Information from Multiple Applications

The POWERLOGIC DDE Module with System Manager or EXPlorer integrates information from multiple applications into a central location. For example, you can integrate information from a Building Automation and Management System. By integrating information from POWERLOGIC and other systems in your facility, you can centralize the information you need onto a workstation or network of personal computers—all in a Windows environment.



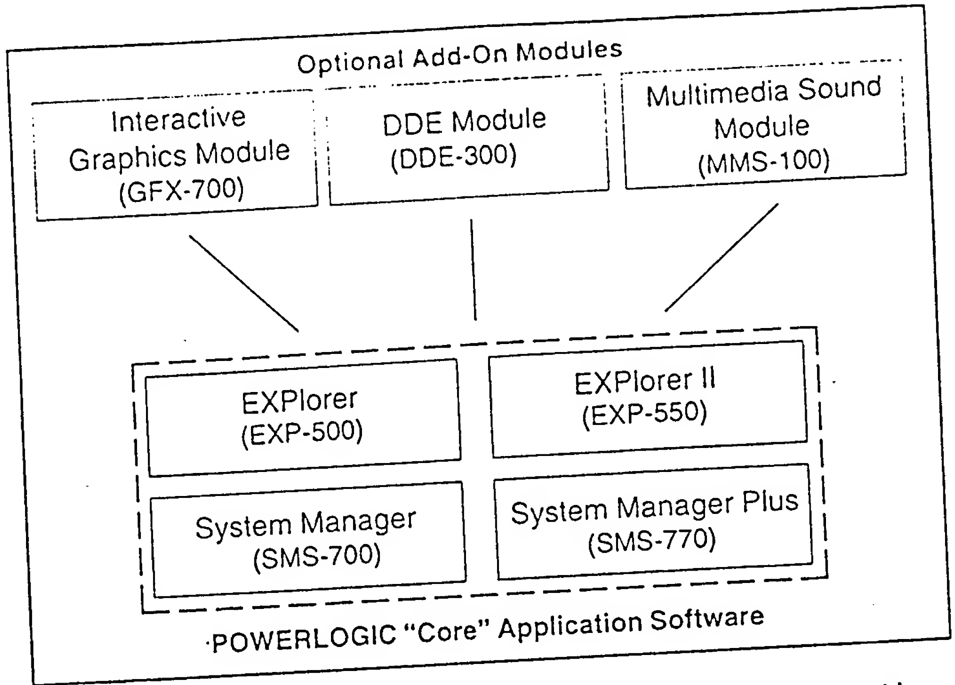
Integrate process control information from programmable logic controllers.

Information is the Key

Comprehensive information about your electrical system is crucial to analyzing and improving its performance and reliability. This data can help you make cost-effective decisions regarding necessary changes or general system operation. The POWERLOGIC system provides clear-cut access to the information you need through EXPlorer and System Manager products. The DDE Module gives other Windows applications real-time access to this same information.

Other POWERLOGIC Software Modules

The POWERLOGIC power monitoring and control system lets you expand your capabilities as needed. The Interactive Graphics Module (GFX-700) is an add-on module to EXPlorer and System Manager. This module lets you display system-wide information on all types of drawings including one-line diagrams, equipment elevations, factory floor plans, and much more. And, by adding the POWERLOGIC Multimedia Sound Module (MMS-100), you can create custom audible alarms in either EXPlorer or System Manager.



POWERLOGIC Technical Support Center

POWERLOGIC offers all of our customers technical support for POWERLOGIC hardware, software and system components. To make sure customers get all the benefits from their power monitoring systems, the Technical Support Center is just a fax or a phone call away.

Application Engineering Services

The POWERLOGIC system is complemented by a staff of highly experienced application engineers whose expertise spans all types of commercial, industrial and utility power systems. Services offered by the Application Engineering Group include automatic PLC based controls, communication network design, custom software screens, and a wide variety of integration services. POWERLOGIC Application Engineering can assist in system design and specification development, system startup, commissioning, and customer training. Each of these is tailored to meet the needs of each project. For more information, contact your local Square D field sales representative.

POWERLOGIC Technical Support Center

- 24 hour fax line
- Tech specialists by phone (7:30-4:30 Central Time)
- Hardware configuration assistance
- Hardware/software operational support
- System layout assistance
- Troubleshooting assistance

Ph: (615) 459-8552
Fax: (615) 459-4294

POWERLOGIC Application Engineering Services

- System design & bill of materials recommendations
- Develop specifications, drawings, and documentation
- Automatic control systems/PLC ladder programming
- Customized hardware/software solutions (DDE Module)
- Installation assistance and startup
- Third party communications interfaces and integration
- On-site and headquarters-based customer training

POWERLOGIC DDE Module

POWERLOGIC Core Software Products

The POWERLOGIC DDE Module works in conjunction with any of the POWERLOGIC core software products. From basic alarming, data logging and event recording, found in POWERLOGIC EXPlorer, to the powerful graphical displays, manual control, macros and more found in POWERLOGIC System Manager Plus, the POWERLOGIC DDE Module gives your Windows applications access to information throughout the POWERLOGIC system. The DDE Module requires one of the "core" products listed in the table below.

POWERLOGIC Core Software Products

Product	Class	Type	Description
EXPlorer	3080	EXP-500	Standard Data Logging, Alarming, Event Recording, Standard Tables for Real Time and Historical Data
EXPlorer II	3080	EXP-550	All EXPlorer Features Plus Waveform Plots with Power Quality Information, User-Scheduled Waveform Logging Feature, and Manual Control
System Manager	3080	SMS-700	Standard Tabular and Graphical Display Types Including Real Time and Historical Data Tables, Analog Meters, Real Time Bar Charts, Status Tables, Time Trend Plots, Waveform Plots with Power Quality Information, User-Scheduled Waveform Logging, Alarming, Standard Data Logging, Event Recording and more
System Manager Plus	3080	SMS-770	All SMS-700 Features Plus Manual Control, Custom Tables, Macro Language

Personal Computer and Software Requirements

Minimum Requirements
- One POWERLOGIC "core" software product
- INTEL 80386 based PC (Micro-channel not supported)
- Windows 386 Enhanced Mode
- Hard disk drive (at least 6MB free space)
- (1) long slot available (for SY/LINK® PC Card)

Recommended for Better Performance
- 80387 Math Coprocessor (with 80386 based Machine), or a higher series processor
- VGA Color Adapter and Monitor
- Additional RAM - 4MB or More

Ordering Information

	CLASS	TYPE
SQUARE D CATALOG NO.	3080	DDE300
CAT. CLASS 3080	3080	
TYPE: DDE-300 (DDE Module)		DDE300

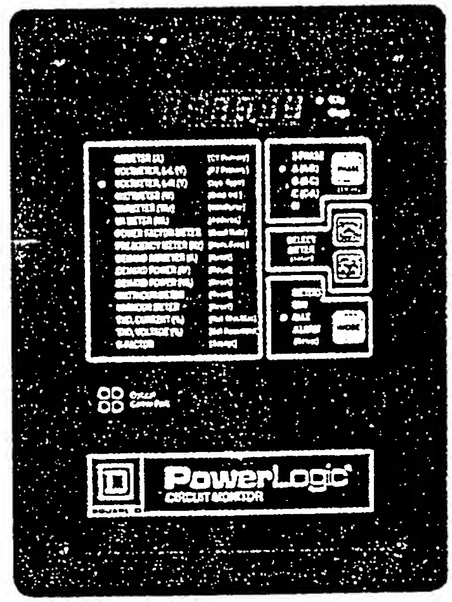
For Further Information - Contact your nearby Square D sales office or call or write to :
Square D Company • POWERLOGIC • 200B Weakley Rd • Smyrna, TN 37167 • (615) 459-8500

Descriptive Bulletin
POWERLOGIC® Circuit Monitor—Series 2000
Class 3020

The POWERLOGIC Circuit Monitor is a multi-function, digital instrumentation, data acquisition and control device capable of replacing a variety of meters, relays, transducers and other components.

Features

- True rms metering (31st harmonic)
- Accepts standard CT and PT inputs
- High accuracy—0.2% current and voltage
- Over 50 displayed meter values
- Min/max displays for metered data
- Power quality readings—THD, k-factor, crest factor
- Harmonic magnitudes and angles through the 31st harmonic
- Current and voltage sag/swell detection and recording
- On-board clock/calendar
- Easy front panel setup (password protected)
- RS-485 communications standard
- Front panel, RS-232 optical communications port standard
- Modular, field installable analog and digital I/O
- 1 ms time stamping of status inputs for sequence-of-events recording
- I/O modules support configurable KYZ pulse output



- Setpoint controlled alarm/relay functions
- On-board event and data logging
- Waveform and event captures, user-selectable for 4, 12, 36, 48, or 60 cycles
- High-speed, triggered event capture
- Programming language for application specific solutions
- Downloadable firmware
- System connections
  - 3-phase, 3-wire delta
  - 3-phase, 4-wire wye
  - Metered or calculated neutral
  - Other metering connections
- Optional voltage/power module for direct connection to 480 Y/277 V
- Optional control power module for connecting to 18–60 Vdc control power
- Wide operating temperature range (–25 to 70° C)
- UL Listed and CSA certified

Instrumentation Summary

Real-Time Readings
- Current (per phase, N, G, 3Ø)
- Voltage (L-L, L-N)
- Real Power (per phase, 3Ø)
- Reactive Power (per phase, 3Ø)
- Apparent Power (per phase, 3Ø)
- Power Factor (per phase, 3Ø)
- Frequency
- Temperature (internal ambient)*
- THD (current and voltage)
- K-Factor (per phase)

Demand Readings
- Demand Current (per-phase present, peak)
- Average Power Factor (3Ø total)
- Demand Real Power (3Ø total)
- Demand Reactive Power (3Ø total)*
- Demand Apparent Power (3Ø total)
- Coincident Readings*
- Predicted Demands*

Energy Readings
- Accumulated Energy, Real
- Accumulated Energy, Reactive
- Accumulated Energy, Apparent*
- Bi-directional Readings*

Power Analysis Values*
- Crest Factor (per phase)
- K-Factor Demand (per phase)
- Displacement Power Factor (per phase, 3Ø)
- Fundamental Voltages (per phase)
- Fundamental Currents (per phase)
- Fundamental Real Power (per phase)
- Fundamental Reactive Power (per phase)
- Harmonic Power
- Unbalance (current and voltage)
- Phase Rotation

* Available via communications only.

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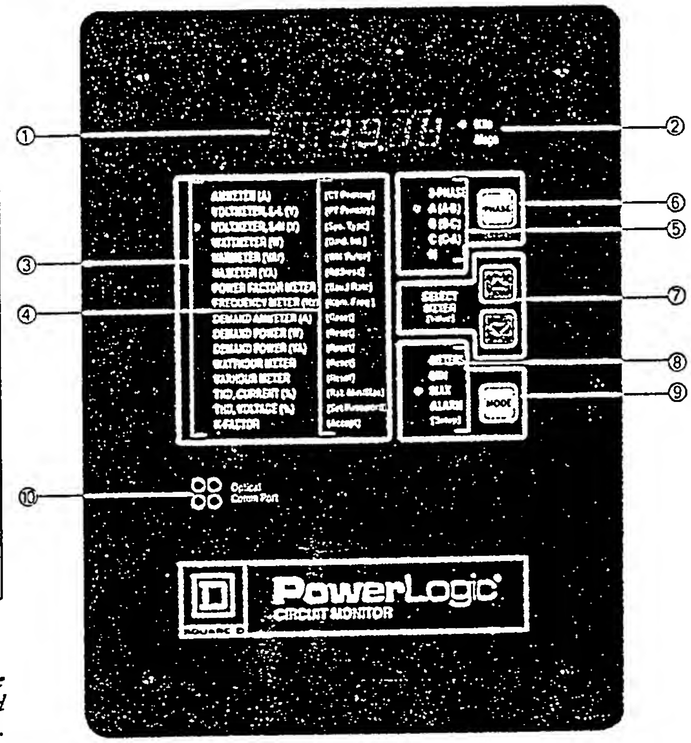
POWERLOGIC Circuit Monitor

Front Panel Features
① Six-Digit LED display
② Kilo/Mega units LEDs
③ Meter Indication LEDs
④ Setup/Reset Parameters
⑤ Phase Indication LEDs
⑥ Phase Select Button
⑦ Select Meter Buttons
⑧ Mode Indication LEDs
⑨ Mode Select Button
⑩ Optical Communications Port



More than 50 metered values plus extensive minimum and maximum data can be viewed from the large 6-digit LED display.

Comprehensive Metering

The POWERLOGIC Circuit Monitor installs on a 3-phase circuit like a conventional watthour meter, but it delivers far more information. In fact, the circuit monitor can replace more than 100 conventional indicating meters. All circuit monitors perform highly accurate, true rms metering. The CM-2050 offers comprehensive metering with 1% accuracy on current and voltage. Models CM-2150 and higher provide 0.2% accuracy on current and voltage, and 0.4% accuracy on power and energy.

Protective Functions

A circuit monitor equipped with an I/O module can perform certain motor protective functions. These include phase loss, phase reversal, under voltage, and more. Once the circuit monitor detects the abnormal condition, the output relay switches within 1–3 seconds. Each protective function can operate one or more form-C, 10 ampere relays. Each relay can be activated by multiple protective functions. These functions are password protected.

Power Quality Readings

Total Harmonic Distortion (THD) for current, voltage, and k-factor readings indicate potential power quality problems which, unchecked, could disrupt critical processes or damage equipment.

Programming Capabilities

The CM-2450 Circuit Monitor is programmed using simple math functions, timers, and compare statements to customize data logging, control functions, and more. For example, instead of logging at regular intervals, data logging can become reports by exception, thus maximizing the circuit monitor's memory. Meter values can be analyzed in the circuit monitor and summarized in daily, weekly, and monthly reports.

Easy Setup

Basic circuit monitor setup can be performed from either the front of the circuit monitor, or a personal computer running POWERLOGIC application software. The PC connects to the circuit monitor using either the system network or an optical communications interface. No thumbwheel or DIP switches are involved; therefore, after installation, setup parameters such as the unit address, CT ratio, PT ratio, and baud rate can be configured without exposing personnel to live conductors. For security, all setup information is password protected.

Flexible Communications

Optically isolated RS-485 communications network circuit monitors into a power monitoring and control system. The industrially hardened network communicates at speeds up to 500k baud. It allows a virtually unlimited number of devices to communicate, including circuit monitors, multiple personal computers, POWERLOGIC trip units for low voltage power circuit breakers, MICROLOGIC® solid state circuit breakers, and other compatible devices.

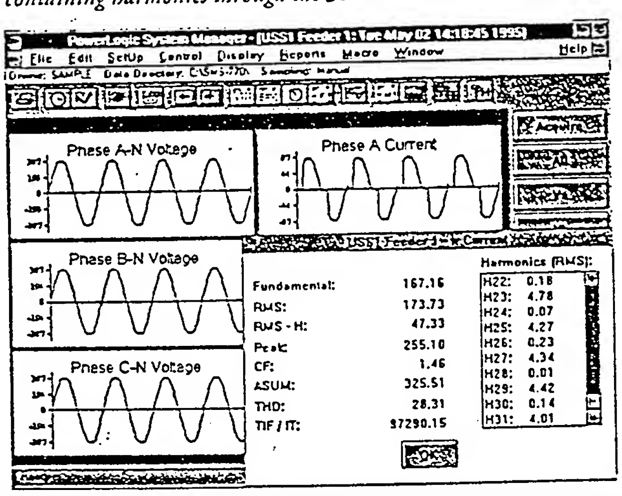
POWERLOGIC
Circuit Monitor

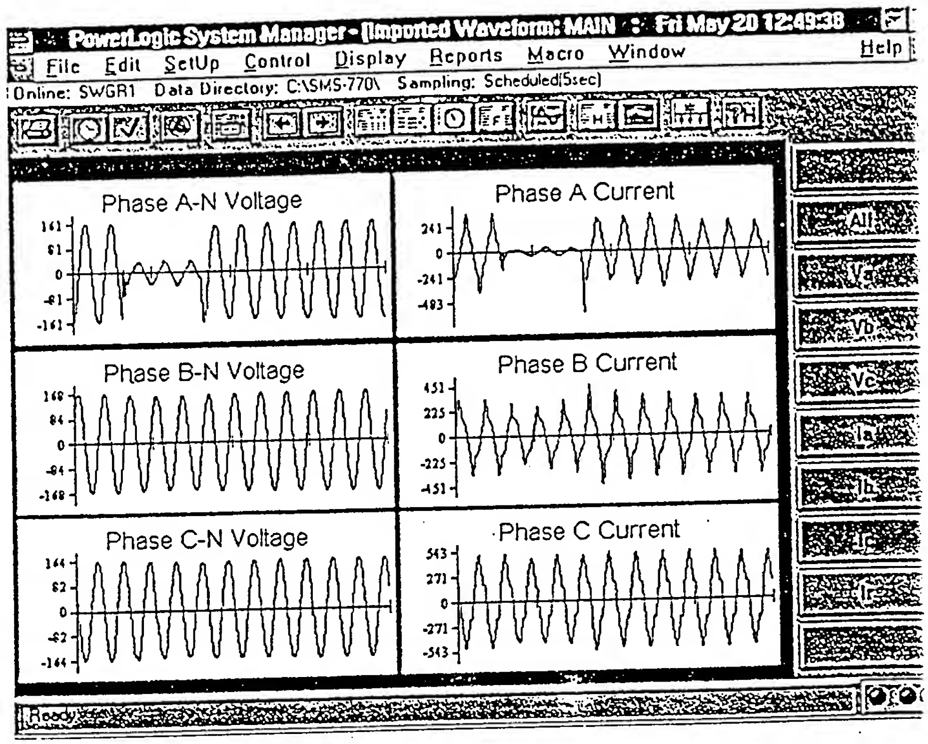
Field Installable I/O Modules

Field installable input/output modules provide maximum flexibility, while keeping the costs for an application at a minimum. An I/O module can be easily installed on the back of the circuit monitor. Seven different I/O modules are available. The modules provide various combinations of digital and analog I/O, ranging from 1 digital input and 1 digital output to 4 digital inputs, 4 digital outputs, 4 analog inputs, and 4 analog outputs.

Two inputs and one output perform special functions. Status input S1 can be configured to accept a demand synch pulse from a utility demand meter. Status input S2 is a high-speed input; it can be connected to an external relay to trigger the circuit monitor's event capture. The KYZ solid-state output is ideal for pulse initiator applications. The form C, 10 amp mechanical relay outputs are extremely flexible — each can be configured for remote (external) or circuit monitor (internal) control. In addition, each output can be configured for normal, latched, timed, or one of six different pulse initiator modes. The analog inputs are field convertible from 0–5 Vdc to 4–20 mA.

POWERLOGIC software can show all phase voltage and current waveforms simultaneously, or a single waveform with a data block containing harmonics through the 31st.





POWERLOGIC software can display sag/sw... data captured by the circuit monitor. This screen shows a voltage sag experienced from a single-phase operation of a recloser.

Waveform Capture

Square D pioneered the concept of "waveform capture." Circuit monitors use a patented, high-speed sampling technique to sample 64 times per cycle on all current and voltage signals simultaneously. The captured waveforms are stored in the circuit monitor memory for retrieval and display by POWERLOGIC application software.

Waveform captures are triggered internally or externally. A personal computer can send a signal over the communications network or through the optical communications port. An external signal for example, from an overcurrent relay, can be received through a high-speed input. The waveform capture can also be triggered internally by any of over 100 user-defined alarm conditions including high or low power factor, %THD, or phase loss.

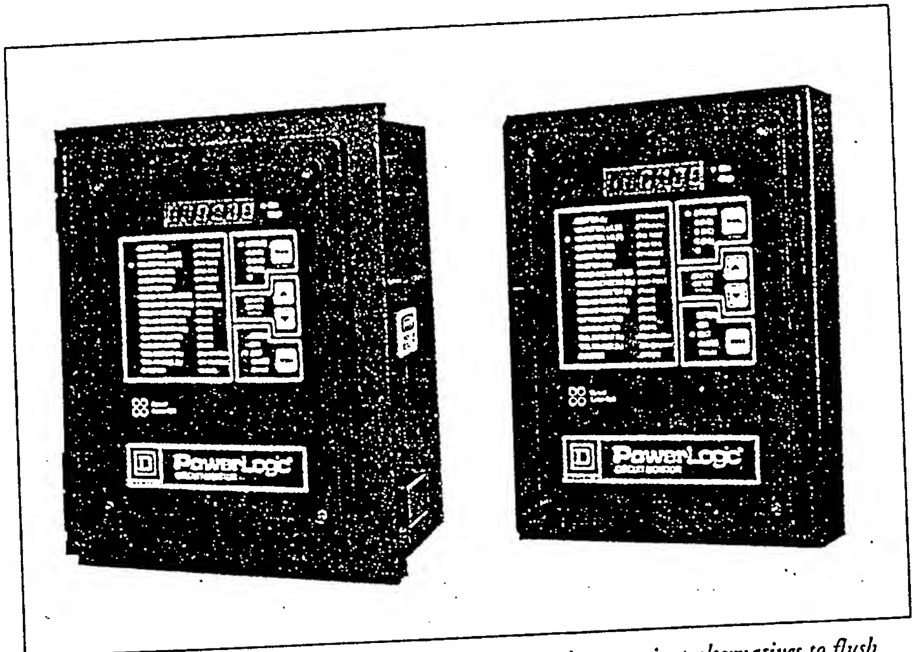
Sag/Swell Detection

The circuit monitor can continuously monitor for sags and swells on any metered voltage or current. This feature can help detect and analyze troublesome voltage disturbances that can cause costl equipment down-time. The circuit monitor detects sags and swells based or user-defined setpoints and delays (in cycles). When the circuit monitor detec a voltage or current disturbance, it performs an event capture to record the disturbance. The event capture is configurable for 12, 24, 36, 48, or 60 cycles. It is performed using the same patented, 64 samples-per-cycle samplin rate as the waveform capture. The user selects the number of pre-event cycles ranging from 2 to 10 cycles. Thus the event capture shows the circuit both *be and after* the disturbance. The event car be date and time stamped to the millise ond, and recorded in the event log.

Mounting Options

In addition to the standard flush mounting, several other mounting options are available. For applications requiring an indoor general purpose surface mounted (NEMA 1) enclosure, a 3090 SMA-220 is used. The circuit monitor mounts through the door of the enclosure, providing easy access to the rear of the monitor. The enclosure is deep enough to accommodate options, including I/O modules and voltage power modules.

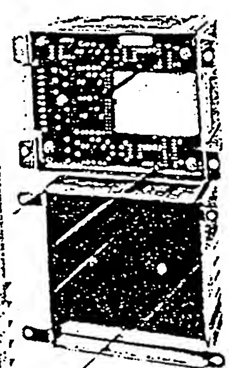
For applications where depth in the equipment enclosure is critical, POWERLOGIC provides the 3090 CMA-100 adapter. The CMA-100 reduces the depth requirements by extending the circuit monitor beyond the front of the equipment.

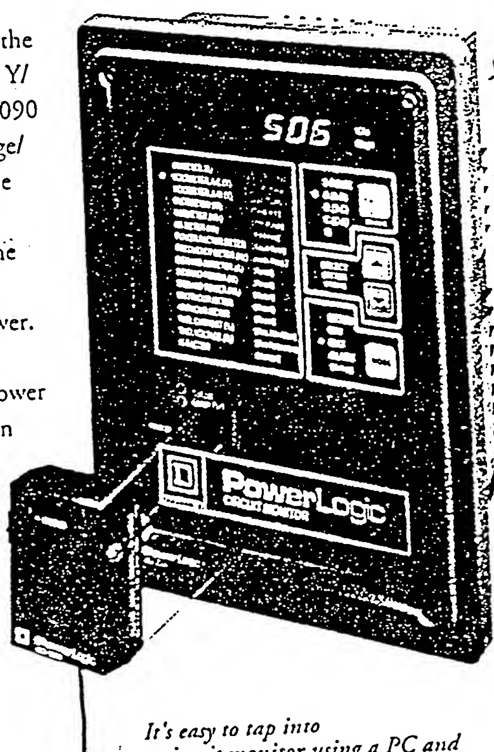


The 3090 SMA-220 (left) and the 3090 CMA-100 provide convenient alternatives to flush panel mounting.

Control Power Options

In addition to CT and PT inputs, the circuit monitor requires control power. The circuit monitor accepts a wide range of voltages including 120/240 Vac nominal or 125/250 Vdc nominal. When the system voltage is 480 Y/277 V, an optional 3090 VPM-277-C1 Voltage/Power Module can be used. This add-on module eliminates the need for PTs and provides control power. The optional 3090 CPM-48 Control Power Module is used when 18–60 Vdc is available. Both modules can be conveniently mounted on the back of a circuit monitor or on a nearby flat surface. To complete the offering, Square D manufactures a complete line of control power transformers.





An I/O module and either a voltage/power module, or a control power module can mount on the back of the circuit monitor.

It's easy to tap into a circuit monitor using a PC and an optical communications interface.

Optical Communications Interface

The circuit monitor has an optical communications port built into the front panel as a standard feature. Using this port, a portable computer with an optical communications interface (OCI-2000) can retrieve data from the circuit monitor. The OCI-2000 mounts magnetically to the circuit monitor and provides a standard RS-232 interface. This interface can be used by engineers and maintenance personnel to retrieve captured waveforms, event and data logs, and other information without connecting to the network.

Extended Memory Options

Circuit monitors provide different amounts of non-volatile memory. For example, the CM-2452 can store over 180,000 values, including dates and times. The memory can be allocated among an event log, a waveform capture log, an event capture log, and up to 14 data logs. (The table to the right shows a typical example of how the user might configure the available memory for various models.)

Typical Memory Configuration①	CM-2050	CM-2150	CM-2250	CM-2350/2450	CM-2452
Event Log	N/A	200 Events	200 Events	500 Events	1500 Events
1 Data Log	N/A	8 Days	8 Days	40 Days	120 Days
Waveform Captures②	N/A	N/A	1	3③	9
Event Captures②	N/A	N/A	1	3③	13④

① The relative size of log files is user-defined. This table illustrates a typical memory configuration with one data log that stores the following data hourly: 3Ø avg. amps, volts (L-L, L-N), PF, kW, kVAR, freq., 3Ø demand for amps, kW, kVA, and kWH and kVARH.

② Waveform & event captures are stored in non-volatile memory in the CM-2350 and CM-2450. The exact number of waveforms and event captures that can be stored depends on how much memory is allocated to event and data logs.

③ Up to 20 waveform captures or 8 12-cycle event captures can be stored in the CM-2350 and -2450, depending on memory allocation.

④ The CM-2452 can store up to 60 waveform captures or 28 12-cycle event captures depending on memory allocation.

Alarm/Relay Functions

Circuit monitors can detect over 100 alarm situations, including over/under conditions, status input changes, and phase unbalance conditions. Each alarm condition can be set to automatically operate one or more circuit monitor relays. Multiple alarms can be assigned to each relay. Up to three form-C, 10 A mechanical relays and one solid-state output are available.

On-Board Alarm/Event Logging

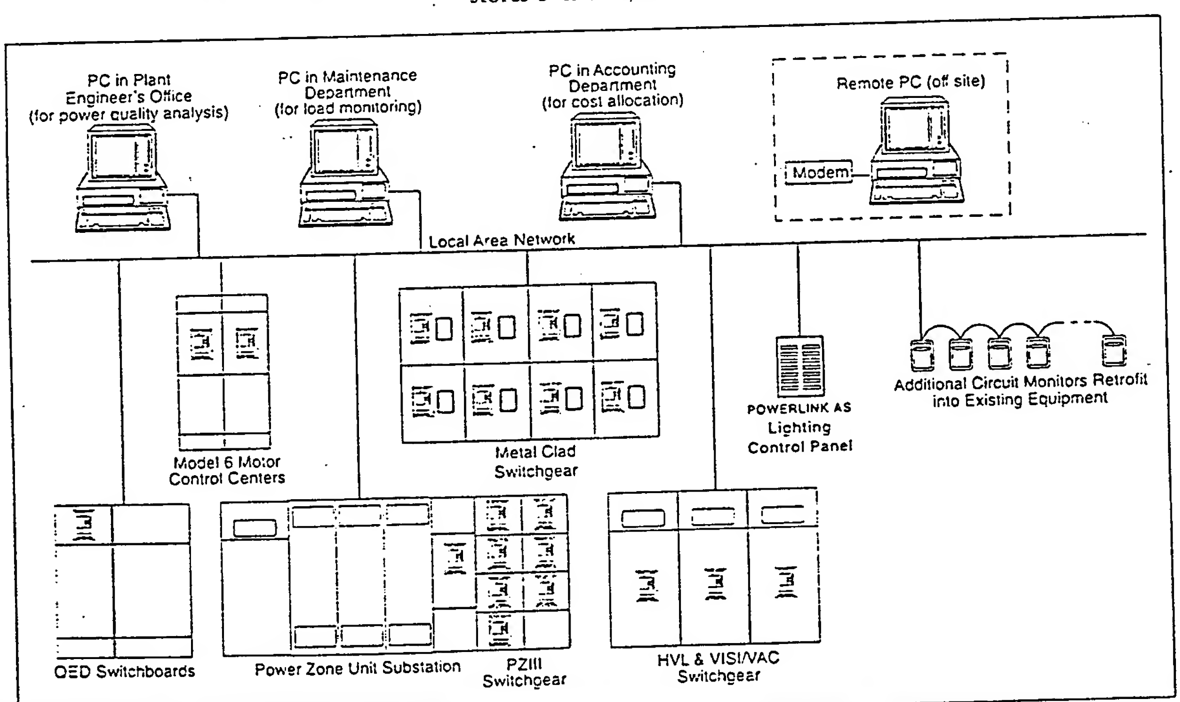
When an alarm occurs, the circuit monitor can log the event type, date and time, and the most extreme reading during the pick-up delay. When the alarm condition drops out, the dropout date/time and the most extreme reading during the entire event will be logged. The size of the event log can be user configured.

Data Logging

Circuit monitors are available with non-volatile memory for storing meter readings at regular intervals. The user can configure the size and structure of up to 14 independent data logs to record metered data at intervals from 1 minute to 24 hours. Each data log entry can contain up to 100 values (including date/time). Models CM-2150 and -2250 store up to 5,632 values. Models CM-2350 and -2450 store up to 51,200 values. Model CM-2452 stores over 180,000 values.

Downloadable Firmware

The circuit monitor is designed to take advantage of technological advances. As Square D introduces more powerful versions of each circuit monitor, upgrade kits allow the user to install the new capabilities without changing wiring or hardware. This is possible because the circuit monitor has downloadable firmware. The new firmware is transmitted from a PC into the circuit monitor, using the front optical communications port or the rear RS-485 port. The equipment containing the monitor does not have to be de-energized. This allows you to keep your circuit monitors up to date with the latest enhancements, minimizing the fear of obsolescence.



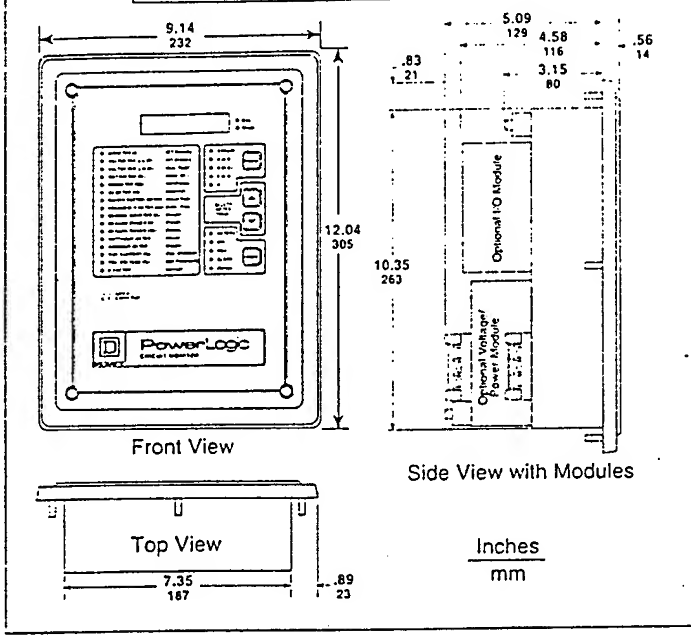
System Highlights

- Supports multiple PCs
- Powerful software solutions
- Easily retrofit
- 500k baud, high speed network
- Programmable controller support
- Fiber-optic, radio, and modem communications
- Ethernet interfaces
- Building automation system compatible

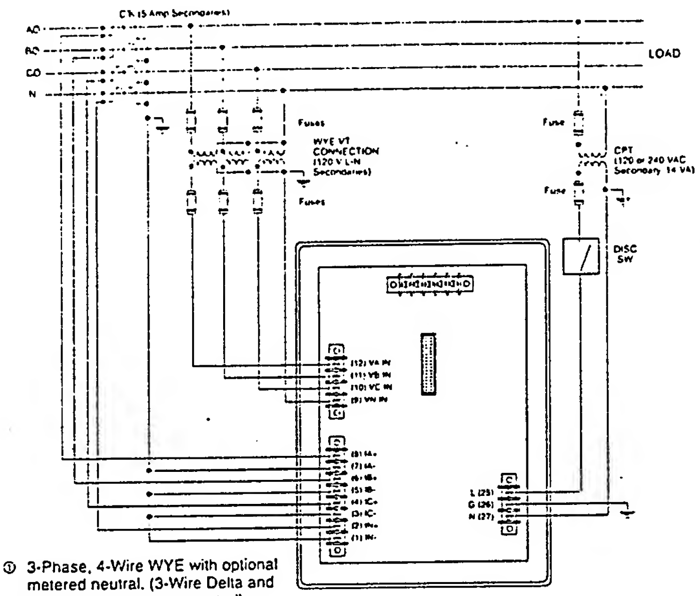
Circuit monitors in a typical POWERLOGIC system.

POWERLOGIC
Circuit Monitor

Circuit Monitor Dimensions



Typical Wiring Diagram①



① 3-Phase, 4-Wire WYE with optional metered neutral. (3-Wire Delta and other system types supported).

Feature Comparison

Feature	CM-2050	CM-2150	CM-2250	CM-2350	CM-2450/2452
Full Instrumentation	x	x	x	x	x
RS-485 Comm Port	x	x	x	x	x
Front Panel Optical Comm Port	x	x	x	x	x
1% Accuracy Class	x				
0.2% Accuracy Class		x	x	x	x
Alarm/Relay Functions		x	x	x	x
On-board Data Logging		x	x	x	x
Downloadable Firmware		x	x	x	x
Date/Time for Each Min/Max		x	x	x	x
Waveform Capture			x	x	x
12-Cycle Event Capture			x	x	x
Extended Memory				100k	100k/356k
Sag/Swell Detection				x	x
Programmable for Custom Applications					x

Ordering Information

Class	Type	Description
3020	CM-2050	Instrumentation, 1% accuracy
3020	CM-2150	Instrumentation, 0.2% accuracy, data logging, alarm/relay functions
3020	CM-2250	Waveform capture, plus CM-2150 features
3020	CM-2350	Disturbance monitoring, 100k extended memory, plus CM-2250 features
3020	CM-2450	Programmable for custom applications, plus CM-2350 features
3020	CM-2452	356k extended memory, plus CM-2450 features
3020	CM-2000U	Circuit Monitor firmware upgrade kit
3020	IOM-11	I/O Module: 1 status IN, 1 pulse OUT
3020	IOM-18	I/O Module: 8 status IN, 1 pulse OUT
3020	IOM-44	I/O Module: 4 status IN, 1 pulse OUT, 3 relay OUT
3020	IOM-4411-20	I/O Module: 4 status IN, 1 pulse OUT, 3 relay OUT, 1 analog IN, 1 analog OUT (4-20 mA)
3020	IOM-4411-01	I/O Module: 4 status IN, 1 pulse OUT, 3 relay OUT, 1 analog IN, 1 analog OUT (0-1 mA)
3020	IOM-4444-20	I/O Module: 4 status IN, 1 pulse OUT, 3 relay OUT, 4 analog IN, 4 analog OUT (4-20 mA)
3020	IOM-4444-01	I/O Module: 4 status IN, 1 pulse OUT, 3 relay OUT, 4 analog IN, 4 analog OUT (0-1 mA)
3090	OCI-2000	Optical communications interface
3090	VPM-277-C1	Voltage/power module for direct connect to 480Y/277V circuits
3090	CPM-48	Control power module to connect circuit monitors to 18-60 Vac control power
3090	SMA-220	Circuit Monitor surface mounting enclosure with hinged cover
3090	CMA-100	Circuit Monitor mounting adapter to reduce rear clearance requirements

Technical Specifications

Metering Specifications

Current Inputs (each channel)
- Current Range .... 0–7.0 A ac
- Nominal Current .... 5 A ac

Voltage Inputs (each channel)
- Voltage Range .... 0–180 Vac
- Nominal Voltage (typical) .... 120 Vac

Freq. Range (50/60 Hz) .... 23–65 Hz
Freq. Range (400 Hz) .... 350–440 Hz

Harmonic Response—Voltage, Current
- Freq. 23 Hz–65 Hz .... 31st Harmonic
- Freq. 350 Hz–440 Hz .... 3rd Harmonic

Accuracy (in percent of full scale) ②
- Current .... +/- 0.20%
- Voltage .... +/- 0.20%
- Power .... +/- 0.40%
- Energy .... +/- 0.40%
- Demand .... +/- 0.40%
- Power Factor .... +/- 0.005
- Frequency 50/60 Hz .... +/- 0.01 Hz
- Frequency 400 Hz .... +/- 0.5 Hz

Control Power Input Specifications
- Input Range, ac .... 100–264 Vac
- Frequency Range .... 47–440 Hz
- Input Range, dc .... 100–350 Vdc
- Burden .... 14 VA

Temp. Range (operating) .... -25 to 70° C

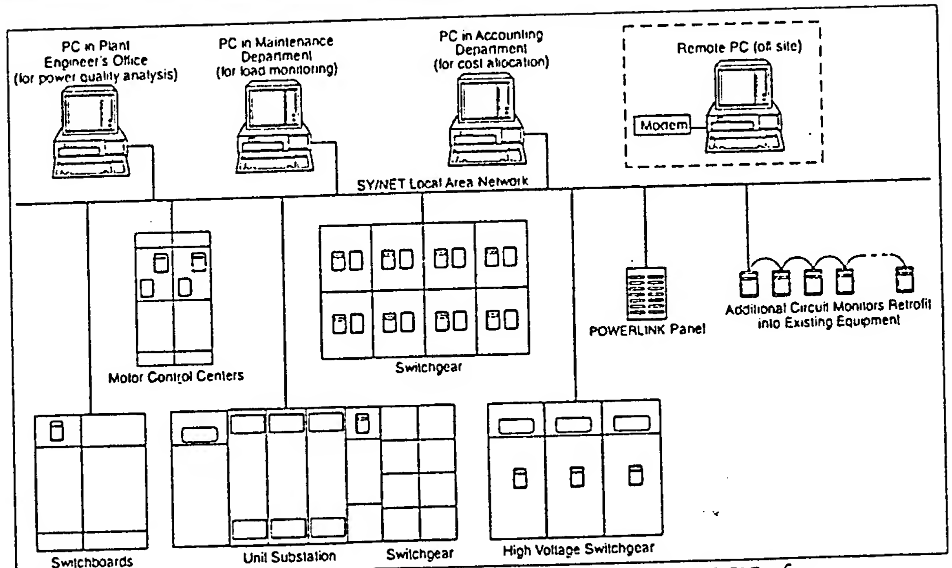
② Accuracies apply to CM-2150, CM-2350, CM-2450 and CM-2452 only. Model CM-2050 meets a 1% accuracy class for current and voltage, and 2% for energy and demand.

SQUARE D
GROUPE SCHNEIDER

Class 3080
Descriptive Bulletin
POWERLOGIC® Power Monitoring and Control System

SYSTEM HIGHLIGHTS

- Supports multiple PCs
- Powerful software solutions
- Easy to retrofit
- 500k baud, high-speed network
- Programmable controller support
- Fiber optic, radio, and modem communications
- Ethernet interfaces
- Building automation system compatible



Each computer on a communications network can be equipped with POWERLOGIC software customized to fit the exact needs of the user.

Profitability with Power Monitoring

Electricity — once considered an uncontrollable cost of doing business — is brought under control through power monitoring and control systems. With a power monitoring and control system, a facility engineer has the ability to locate trouble spots and prevent outages or downtime, as well as determine energy use by department or product line.

Square D's POWERLOGIC Power Monitoring and Control System is an innovative total system solution to managing electricity and improving the reliability of power distribution equipment. The POWERLOGIC system combines microprocessor-based instrumentation and control to provide advanced features for industrial, commercial, and utility electrical systems. The POWERLOGIC system's exceptionally accurate instruments, high-speed communications network, and fully-integrated power monitoring application software make these benefits possible.

How do power monitoring and control systems work?

Power monitoring systems monitor the flow of electrical power in circuits throughout the plant. In the POWERLOGIC system, highly accurate Circuit Monitors are dedicated to power monitoring, while other compatible devices collect additional equipment information from protective relays, trip units, circuit breakers, transformer temperature controllers, and panelboards.

Electrical data — such as current, power, energy, waveforms, and equipment status — is passed over a data network to a personal computer. Each personal computer runs power monitoring application software that retrieves, stores, organizes, and displays real-time circuit information in simple, usable formats.

The information collected and stored in a power monitoring system helps operate a facility more efficiently. Of course, the quality of the data depends on the accuracy of the instrumentation and the usability of the display formats. A POWERLOGIC system provides this accuracy in a format that is easy to use and understand.

SQUARE D
GROUPE SCHNEIDER

POWERLOGIC. The Total System Solution

Accurate Monitoring Devices

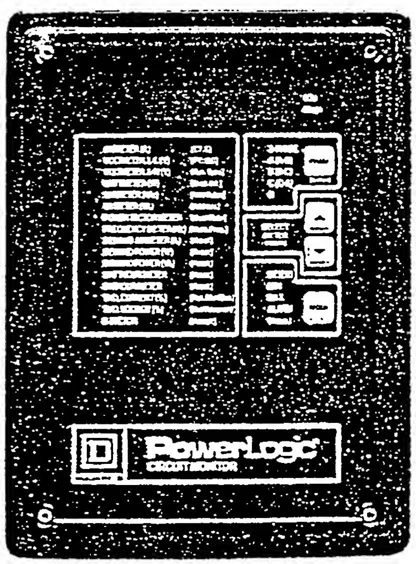
Each POWERLOGIC device is a multi-function, digital instrumentation, data acquisition and control device capable of replacing a variety of meters, relays, transducers, and other components.

POWERLOGIC system devices can be integrated with Square D's electrical power distribution products or retrofit into existing equipment. The result is a distributed network of intelligent, accurate monitoring devices reporting to one or more centralized locations.

Flexible Connectivity and Network Topologies

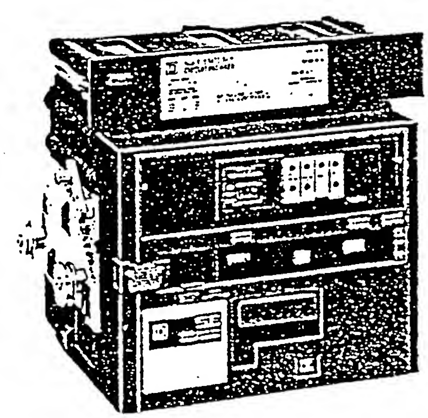
All POWERLOGIC-compatible devices are equipped with an RS-485 network communication port for integration into a POWERLOGIC power monitoring and control system. In addition to the RS-485 port, the POWERLOGIC Circuit Monitor has an infrared optical communications port on its front panel. A small optical communications interface, which attaches magnetically to the front of the Circuit Monitor, provides an RS-232 link to a portable computer.

Using the standard RS-485 port, up to 32 devices can be daisy-chained and directly connected to a personal computer, System Display, or POWERLOGIC Network Interface Module (PNIM). To optimize performance, the POWERLOGIC power monitoring and control system can use Square D's SY/NET® network (although not required). The SY/NET network supports communication speeds through 500k baud, distances up to 15,000 feet, and virtually limitless device connections. Other communication options such as fiber optics, modem, and Ethernet are also available. POWERLOGIC makes it easy to allow localized, distributed, remote, and any mixed network combination.



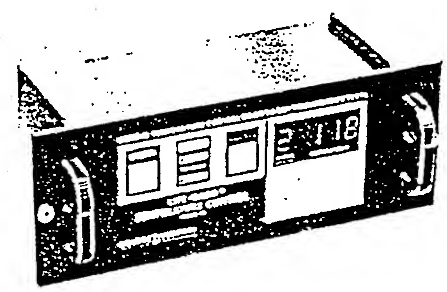
POWERLOGIC Circuit Monitor

- True rms metering through the 31st harmonic
- 0.2% accuracy on current and voltage
- Over 50 displayed metered values
- Waveform capture
- THD and K-factor power quality readings
- Min/Max displays for all metered quantities
- Alarm/Relay functions
- Onboard event and data logging
- Digital and Analog I/O (optional), KYZ Pulse Initiator
- Direct connect 480Y/277V (optional)



Product Interface for MICROLOGIC® Circuit Breakers

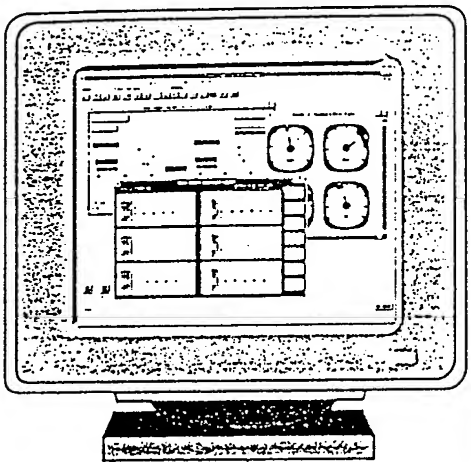
- Enables POWERLOGIC system to access MICROLOGIC full function circuit breaker data
- Reports per-phase rms and ground fault currents, historical trip data, and circuit breaker data and trip settings
- Each PIF-3 supports up to 8 circuit breakers



Product Interface for LIFEGARD® Temperature Control

- Enables the POWERLOGIC system to access LIFEGARD Model-85 Transformer Temperature Control data
- Reports individual and hottest coil temperature, fan and relay status, and transformer type

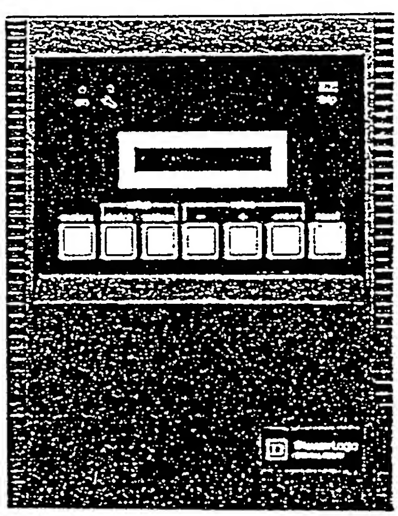
for Smart Power Management.



Organized and Usable Information

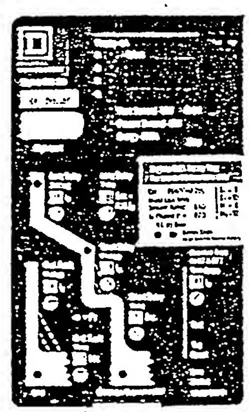
The POWERLOGIC application software series automatically integrates real-time circuit information into organized and usable formats. Without any custom programming and very minimal setup, the user can readily access real-time and historical data, time trend plots, alarms, waveform plots, power quality information, data logging, output control, and more.

By understanding your system, you can easily maintain greater efficiency through decreased demand and power factor penalties, lower energy consumption, better equipment utilization, and reduced downtime and maintenance. POWERLOGIC has several software packages with a range of capabilities to meet your needs. POWERLOGIC application software puts the power of information to work.



POWERLOGIC Digital Relay

- Three-phase and ground overcurrent protection (ANSI 50/51)
- User-selected time-current curves
- Local keypad and display of metering and diagnostics
- Reports per-phase rms and ground fault currents, demand currents per-phase, breaker status, and cause of trip (fault type and magnitude)
- Remote breaker operation
- 120 Vac or 48/125 Vdc control power options



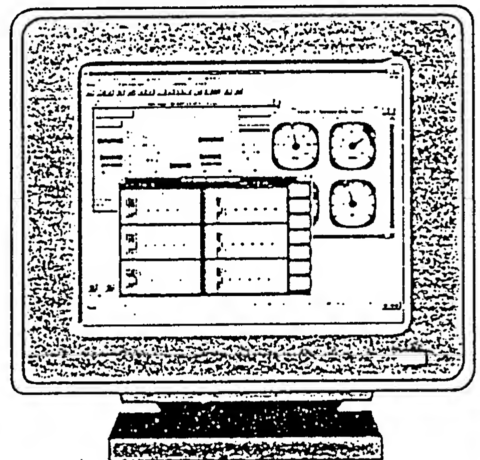
POWERLOGIC Trip Unit for Low Voltage Power Circuit Breakers

- Includes all protection features of the standard Digitrip series
- True rms sensing
- Local readout of metering and diagnostics
- Reports per-phase rms and ground fault currents, demand currents, breaker status, and cause of trip (fault type and magnitude)
- Remote open/close circuit breaker
- Integral to breaker — no external current or potential transformers required

Powerful Software Solutions

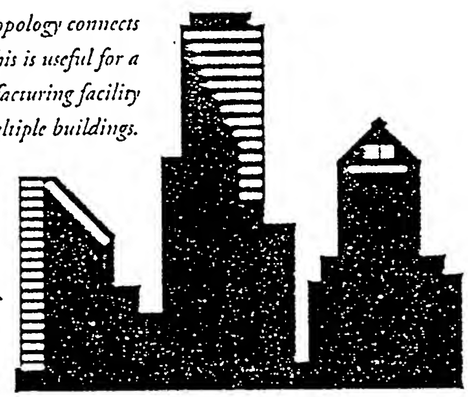
The POWERLOGIC application software series offers a variety of power monitoring solutions.

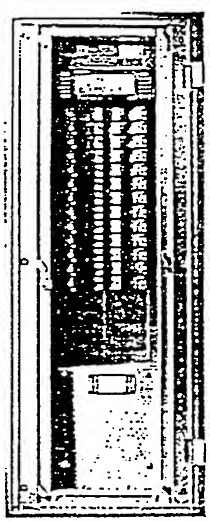
From Product Communications Software (PSW), an entry level, DOS-based product, to System Manager Plus,™ an advanced, system-wide, Microsoft® Windows™-based product, POWERLOGIC software allows you to monitor, display, and store vast amounts of information from all of the POWERLOGIC-compatible devices.



Localized Topology connects the devices in a single industrial or commercial facility.

Distributed Topology connects building to building. This is useful for a campus or large manufacturing facility with multiple buildings.





POWERLINK AS

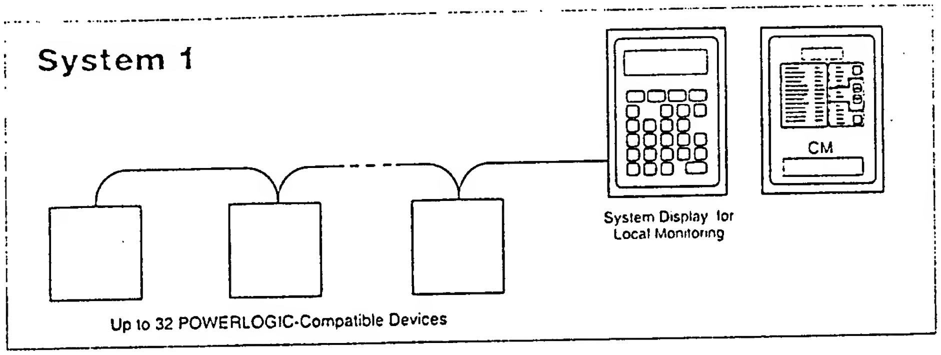
- Self-contained control within panelboard
- Local keyboard with large LCD display
- Zone configuration and control
- Time-of-day scheduling
- Daylight savings, event/holiday programs
- RS-485 and RS-232 communications
- Network-compatible with POWERLOGIC system and SY/MAX® PLCs
- Full override and run/wait/hold modes

Remote Topology connects multiple facilities.

POWERLOGIC System Options

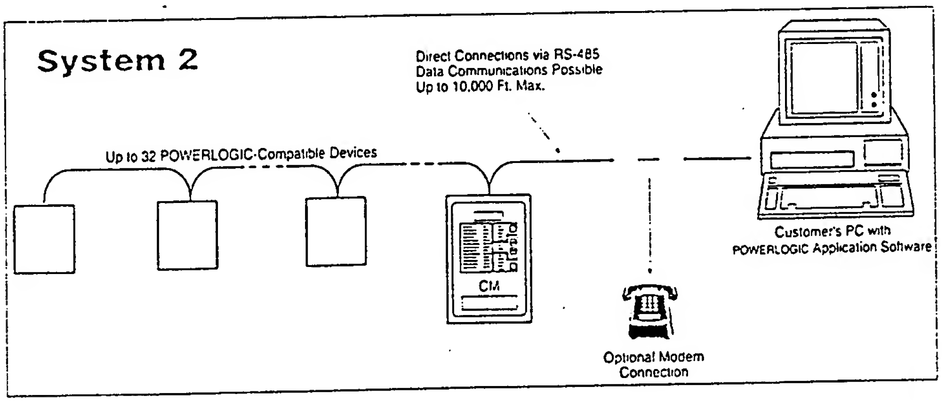
System 1 — Local Monitoring

POWERLOGIC Circuit Monitors can be a stand-alone system. Each Circuit Monitor is equipped with a front panel display and front optical port, which allows for retrieval of onboard logging data. Also, System Displays provide local monitoring when connected to MICROLOGIC circuit breakers or other compatible devices.



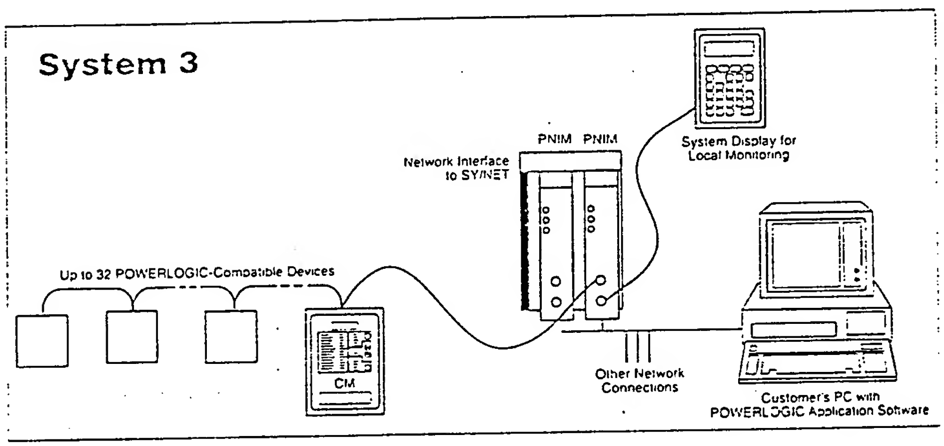
System 2 — Direct Connect Remote Monitoring

One or more POWERLOGIC Circuit Monitors, MICROLOGIC circuit breakers, and other POWERLOGIC-compatible devices (any combination up to 32) can be directly connected to a personal computer. This provides the flexibility of remote real-time monitoring and data collection.



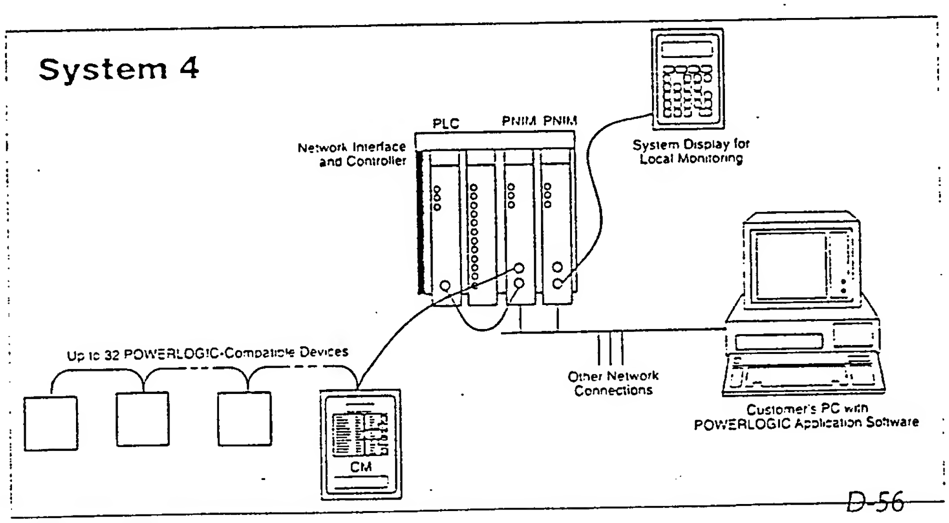
System 3 — Network Monitoring

This provides the flexibility of remote real-time monitoring and data collection for virtually limitless devices. One or more POWERLOGIC Circuit Monitors, MICROLOGIC circuit breakers, and other POWERLOGIC-compatible devices (up to 32) can be connected to a POWERLOGIC Network Interface Module (PNIM) for connection to the SY/NET[1] Local Area Network (LAN).

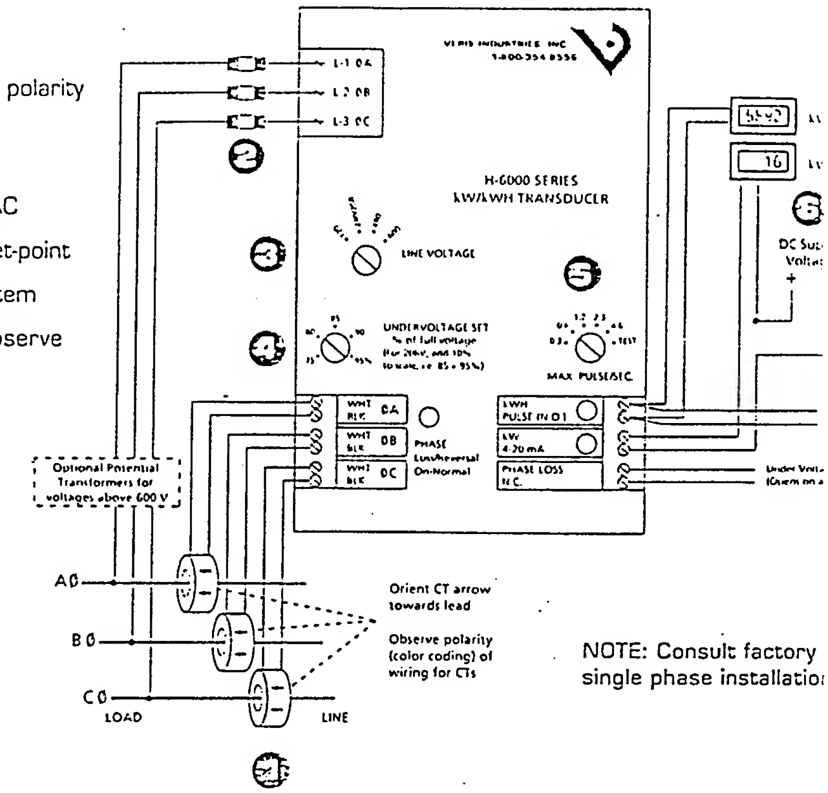


System 4 — Network Monitoring And Automatic Control

In addition to the components shown for System 3, a SY/MAX programmable controller can provide automatic control capabilities on a custom basis.



1. Veris Safe Split Core CTs-1.0 V output. Orient CT arrow towards load. Observe polarity (color coding) of wiring for CTs
2. Fuse or breaker per NEC
3. Select desired line voltage up to 600 VAC
4. Undervoltage/phase loss percentage set-point
5. Pulse rate selection per automation system
6. Non-polarity sensitive 4-20 mA loop. Observe panel polarity
7. For voltage output, install resistor at automation panel. Consult factory for installation requirements



SPECIFICATIONS

Transducer Model 6001 kW & kWH

Amperage Ratings..............*0 - 2400 A (sized by CT; consult factory for higher amperages)*
Amperage Input..............*1.0 V Safe CTs ONLY....Consult factory for 0-5 A output CT retrofit interface*
Voltage Range (field selectable)..............*120, 208, 240, 277, 480 or 600 VAC (other ranges: consult factory)*
Isolation..............*2500 VAC rms*
Analog Output..............*4-20 mA*
Pulse Output..............*N.O., Opto FET, 100 mA @ 24 VAC/DC*
Pulse Rate..............*Field selectable 1, 0.5, 0.1, 0.05 pulse/KWH*
Phase loss/low voltage alarm output rating..............*N.C., Opto FET, 100 mA @ 24 VAC/DC*
Low voltage alarm trip point..............*Adjustable 75 - 95%*
Sealing..............*N.E.M.A. 1. Consult factory for other NEMA enclosures*
Temperature Range..............*-15 to 40 C*
Humidity Range..............*0 - 95% non-condensing*
Enclosure Dimensions..............*(L x W x D).....8.0" x 8.0" x 4.0"*
Model H-6005 (no enclosure dimensions)..............*(L x W x D).....7.0" x 4.0" x 3.0"*
Enclosure Construction (except model 6005)..............*Steel, NEMA type 1, conduit knock outs, hinged door*

NOTE: Fuse pack rated only to 600 VAC; 100 KAIC source max. Install per NEC & local codes only.
This product uses Veris 1.0 V output CTs. To interface with 0.5 A CTs (e.g. 800:5) consult factory.

ORDERING INFORMATION

Part #	Description
H-6001	kW/kWH Transducer in *N.E.M.A. 1* enclosure
H-6002	kWH LCD display front mounted in H-6001
H-6004	kW/kWH LCD displays front mounted in H-6001
H-6005	kW/kWH Transducer for mounting in field enclosure
H-6901	Fuse pack 600 V, 100 KAIC max

NOTE: Order CTs separately. See page 10

METERING PRODUCTS

Hawkeye® 6000 Series

kW & kWH MONITORING

kW and kWH Transducers/Submeters

Applications

- *Energy management & performance contracting*
- *Submetering for commercial tenants*
- *Departmental costing in manufacturing facilities*
- *Power monitoring for tool wear and process control*

SAFE CTs...eliminates need for costly CT shorting bars

- *Current transformers (CTs) utilize accurate low-voltage output... non hazardous, even if left unshorted!*
- *Eliminates need for current shorting bars*
- *Split-core CTs no need to remove conductor, easy installation*

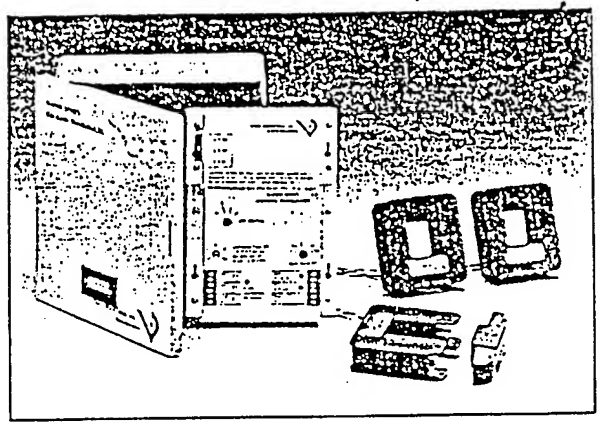
Easy installation

- *Compact conduit enclosed H-6001 measures just 8" X 8" x 4" (LxWxD)*
- *Conduit ready version features hinged panel door with padlock hasp*
- *No expensive potential transformers (PTs) for 600 V or less*
- *Powered by voltage inputs...no costly power supplies*
- *Easy field voltage selection (120 to 600 VAC)*
- *4-20 mA output loop continuity LED*
- *Pulse output rate LED...high pulse rate test mode*

Accurate analog and pulse outputs

- *Accurate to +/- 0.5%..true RMS power!*
- *Exceeds ANSI C12.1 Standards*
- *4-20 mA output for demand kW*
- *Pulse output for kWH...adjustable rate compatible with all automation systems and data loggers*
- *Adjustable undervoltage & phase loss/reversal output protects valuable equipment. Fail-safe.*
- *kW and/or kWH display options. kWH maintains reading in event of power loss*

Great for automation systems! • • •



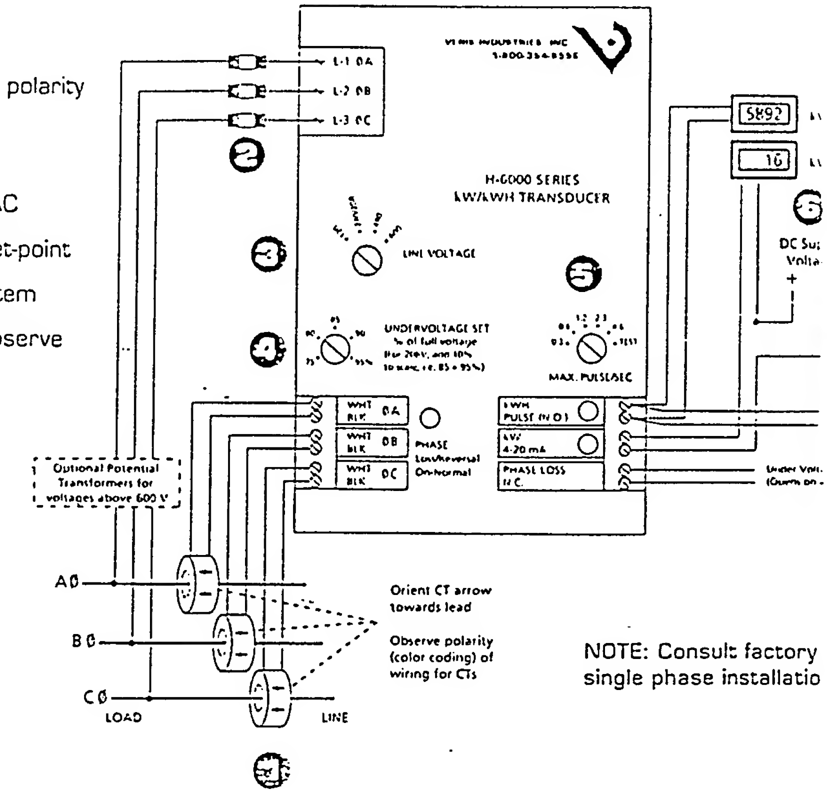
OPERATION

The 6001 is a one to three phase industrial grade automation system kW/kWH transducer. The H-6001 accepts three Veris 1.0 V current transformer inputs and three direct connect voltage inputs. The transducer multiplies the input current signal and voltage input for each phase to calculate true RMS power. The instantaneous power (kW) of all three phases is summed and converted to an industry standard 4-20 mA output signal for use in demand management (load shedding) applications. The sensor also accumulates this instantaneous value over time and produces a pulsed output proportional to the energy usage (kWH). The frequency of the output pulses is proportional to the total power consumed and can be used to measure energy usage for an entire building, selected area, or individual loads (chillers, compressors, etc.).

Pulse rate ouput is also field selectable to match the requirements of virtually all automation panels and data loggers. kW range is determined by the ampere ranges of the CTs used to provide the input current signal.

NOTE: To interface with 0 - 5 A CTs, consult factory.

1. Veris Safe Split Core CTs-1.0 V output. Orient CT arrow towards load. Observe polarity (color coding) of wiring for CTs
2. Fuse or breaker per NEC
3. Select desired line voltage up to 600 VAC
4. Undervoltage/phase loss percentage set-point
5. Pulse rate selection per automation system
6. Non-polarity sensitive 4-20 mA loop. Observe panel polarity
7. For voltage output, install resistor at automation panel. Consult factory for installation requirements



NOTE: Consult factory single phase installatio

SPECIFICATIONS

Transducer Model 6001 kW & kWH

Amperage Ratings	*0 - 2400 A (sized by CT; consult factory for higher amperages)*
Amperage Input	*1.0 V Safe CTs ONLY....Consult factory for 0-5 A output CT retrofit interface*
Voltage Range (field selectable)	*120, 208, 240, 277, 480 or 600 VAC (other ranges: consult factory)*
Isolation	*2500 VAC rms*
Analog Output	*4-20 mA*
Pulse Output	*N.O., Opto FET, 100 mA @ 24 VAC/DC*
Pulse Rate	*Field selectable 1, 0.5, 0.1, 0.05 pulse/KWH*
Phase loss/low voltage alarm output rating	*N.C., Opto FET, 100 mA @ 24 VAC/DC*
Low voltage alarm trip point	*Adjustable 75 - 95%*
Sealing	*N.E.M.A. 1. Consult factory for other NEMA enclosures*
Temperature Range	*-15 to 40 C*
Humidity Range	*0 - 95% non-condensing*
Enclosure Dimensions	*(L x W x D).....9.0" x 8.0" x 4.0"*
Model H-6005 (no enclosure dimensions)	*(L x W x D).....7.0" x 4.0" x 3.0"*
Enclosure Construction (except model 6005)	*Steel, NEMA type 1, conduit knock outs, hinged door*

NOTE: Fuse pack rated only to 600 VAC; 100 KAIC source max. Install per NEC & local codes only.
This product uses Veris 1.0 V output CTs. To interface with 0.5 A CTs (e.g. 800:5) consult factory.

ORDERING INFORMATION

Part #	Description
H-6001	kW/kWH Transducer in *N.E.M.A.* 1 enclosure
H-6002	kWH LCD display front mounted in H-6001
H-6004	kW/kWH LCD displays front mounted in H-6001
H-6005	kW/kWH Transducer for mounting in field enclosure
H-6901	Fuse pack 600 V, 100 KAIC max

NOTE: Order CTs separately. See page 10

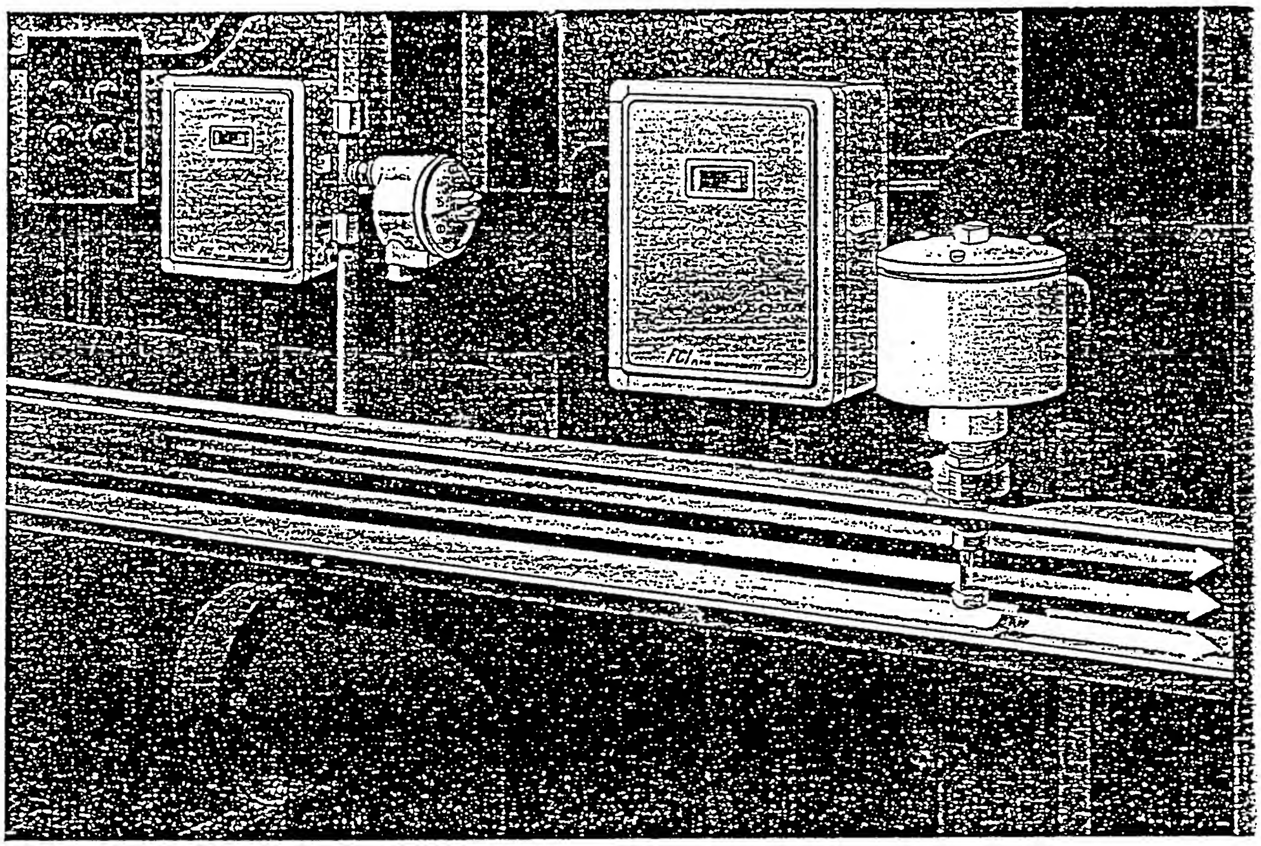
UL LISTED 1244

VERIS INDUSTRIES, INC.
Power Monitoring Solutions

FCI GF Series.

Smart Thermal

Single-Point



Mass Flowmetering

for Gas Applications.

FCI

The GF Series Gas Mass Flowmeters combine FCI's highly reliable Thermal Dispersion, no-moving-parts flow element design with an advanced microprocessor-based programmable transmitter. Performance and durability are unmatched in tough industrial applications ranging from exhaust stack gas to digester gas to hydrogen make-up gas flowmetering.

Reliability, Flexibility in Industrial Applications The GF Series Mass Flowmeters are available in two models: the GF90 with an insertion flow element and the GF92 with an in-line flow tube flow element. Both models feature standard 316 stainless steel, nickel braze construction. Corrosion- and abrasion-resistant alloys and all-welded construction are available for select service in harsh process environments.

FCI's advanced constant power Thermal Dispersion technology provides the GF Series Mass Flowmeters with turndowns up to 1000:1, repeatability of ±0.5% reading or better, and flow rate accuracy of ±1% reading + 0.5% full scale.

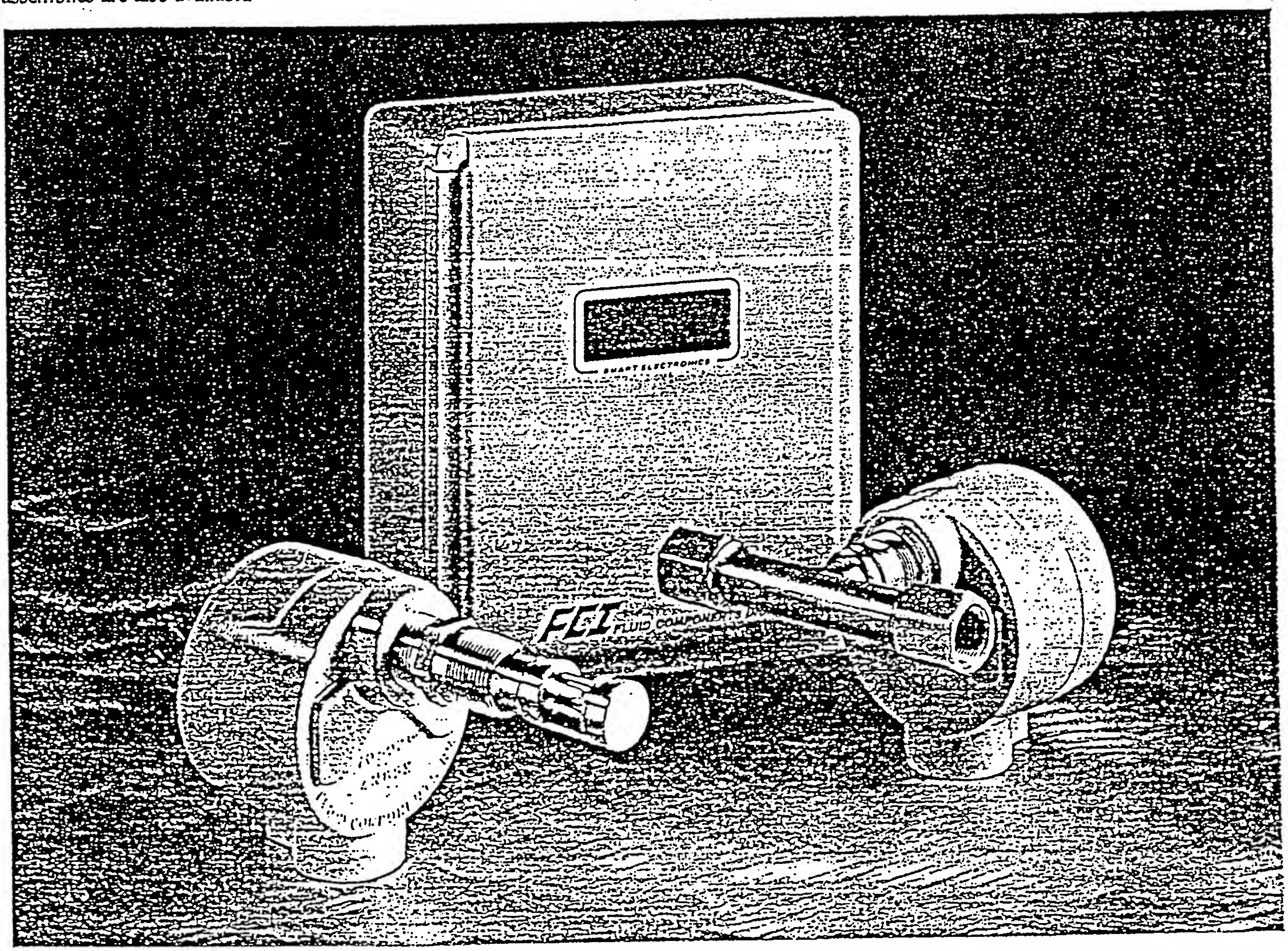
The GF90 Insertion Model The GF90 is available for use in ducts or pipe sizes with a suggested minimum 2.0 inch (5.1 cm) nominal inside diameter. The standard flow element has a 1 inch male NPT process connection and an application specific insertion length. Flange connections and field retractable packing gland assemblies are also available.

Flow sensitivity ranges from 0.25 to 1600 SFPS (ft/sec at a standard temperature of 70°F and pressure of 14.7 psia) or 0.08 to 487.7 NMPS [m/sec at a normal temperature of 21.1°C and pressure of 1.013 bar (absolute)].

The GF92 In-Line Model The GF92 is used for gas mass flowmetering in pipe lines or tubing sizes from 0.125 to 3 inches (0.3175 to 7.62 centimeters). It has a standard body length of 7.25 inches (18.4 centimeters) for installation in 1 inch (2.54 centimeters) flow tubes and 12 inches (30.48 centimeters) for 1.5 to 3 inch (3.81 to 7.62 centimeters) pipe sizes. Custom lengths are also available.

Flow sensitivity ranges from 0.006 to 2000 SCFM (ft^3/min at a standard temperature of 70°F and pressure of 14.7 psia) or 0.01 to 3398 NCMH [m^3/hr at a normal temperature of 21.1°C and pressure of 1.013 bar (absolute)]. Contact FCI or an FCI representative for the specific flow range sensitivity for your application.

Smart Electronics The GF Series' microprocessor-based electronics are easily addressable via a built-in keypad or through the serial ports and allow complete in-field reconfiguration to the instrument's performance parameters (i.e., the changing of relay set points, output zeros and spans, display units, and installation and operation parameters within the calibrated instrument range). RS-232C and RS-485 serial ports provide the ability to interface with a computer or any ASCII-oriented terminal.



GF Series Gas Mass Flowmeters General Specifications

Application

Gas mass flow measurement.

GF90: In ducts or pipe sizes with a minimum 2.0 inch (5.1 cm) nominal inside diameter.

GF92: In pipe lines or tubing sizes from 0.125 to 3 inches (0.3175 to 7.62 centimeters).

Flow Elements

Process Connection:

GF90: 1 inch male NPT standard. Flange connections and field retractable packing gland assemblies available.

GF92: 3/4 inch female NPT standard. 1.0, 1.5, 2.0 and 3.0 inch male or female NPT, flange connections available.

Insertion Length – GF90: Variable length. Specify insertion "U" length (dimension from the process connection to the tip of the flow element) to extend the tip of the flow element 1 inch (2.5 cm) past the centerline of the process pipe.

Body Length – GF92: 7.25 inches (18.4 cm) for 1 inch flow tubes; 12.0 inches (30.5 cm) for 1.5 to 3 inch (3.81 to 7.62 cm) pipe spool pieces.

Flow Element Material: All wetted surfaces are 316 stainless steel with nickel braze. Corrosion-resistant alloys are available with factory specified all welded construction or compatible brazes.

Flow Element Range:

GF90: 0.25 to 1600 SFPS for most gases (ft/sec at a standard temperature of 70°F and pressure of 14.7 psia) or 0.08 to 487.7 NMPS [m/sec at a normal temperature of 21.1°C and pressure of 1.013 bar (absolute)].

GF92: 0.006 to 2000 SCFM for most gases (ft^3/min at a standard temperature of 70°F and pressure of 14.7 psia) or 0.01 to 3398 NCMH [m^3/hr at a normal temperature of 21.1°C and pressure of 1.013 bar (absolute)].

Actual velocity for both the GF90 and GF92 must be limited to a maximum of 200 feet per second (60.96 meters per second).

Temperature Range: –50°F to +350°F (–45°C to +176.7°C) with the standard temperature flow element. The GF90 is available in a High Temperature Flow Element configuration for service in process temperatures from –100°F to +850°F (–73.3°C to +454.4°C).

Operating Pressure: Up to 1000 psig [68.9 bar (gauge)].

Transmitter

Signal Output:

Analog: Two independent signal outputs available that may be field set from the following listed selection:

4-20 mA, 600 ohms maximum load
0-10 VDC, 5000 ohms minimum load
0-5 VDC, 2500 ohms minimum load
1-5 VDC, 2500 ohms minimum load

Digital: RS-232C and RS-485 serial ports.

Switch Points (Dual Alarms): The switch points may be field set by programming the GF90 or GF92 to alarm at high, low or windowed flow or at high, low or windowed process temperature.

Relays: Two independently adjustable 10 amp at 115 VAC and 24 VDC or 2 amp at 230 VAC.

Slaved Relay Energization Terminals: Customer provided relay may be energized at programmable values by connecting to points on the output terminal strip.

+Ext Relay: 20 VDC, sourcing up to 100 mA total both relay outputs.

–Ext Relay: Open/Ground (switching).

Power Input: 115 VAC, ±15 VAC, 16 watts maximum or 230 VAC, ±30 VAC, 16 watts maximum, or 24 VDC, –2 and +6 VDC, 16 watts maximum as selected by the power input switch and terminal selection.

Indicator Display & Built-In Keypad: 4 lines by 20 character liquid crystal display that may be programmed to indicate flow rate, total flow, temperature, and switch point status in customer determined English or Metric (SI) values. Keypad permits easy touch programming to change zero, span, switch points, and units of measurement and for instrument verification, trouble shooting and other critical instrument functions.

Electrical Enclosures

Local Flow Element & Flow Transmitter: Available with fiberglass NEMA 4X (designed to meet IP65) enclosure.

Flow Element: Available with aluminum or steel Class 1, Division 1, Groups B,C,D FM (CENELEC EExIId) explosion-proof or fiberglass NEMA 4X (designed to meet IP65) local enclosure.

Remote Flow Transmitter: Available with fiberglass NEMA 4X (designed to meet IP65) or optionally with aluminum Class 1, Division 1, Groups C, D FM (CENELEC EExIId) explosion-proof enclosure. Other approval certifications are available. Contact your FCI representative for more information.

Electrical Connection: 1 inch female NPT.

Temperature Range: 0°F to +150°F (–18°C to +65.6°C).

Flow

Accuracy: ±1% reading + 0.5% full scale.

Repeatability: ±0.5% reading or better.

Turndown Ratio: Field set to within specified flow range from 2:1 to 100:1. Turndown ratios up to 1000:1 are possible in some applications. Signal output may be field set to be zero or non-zero based. Up to three independent calibrations may be stored in the GF Series transmitter and selected via the built-in keypad, RS-232C or RS-485 Serial Ports or Auxiliary Input Terminal (4-20 mA).

Calibration Adjustment: Up to three independent calibration groups are available. Each group is precisely calibrated at the factory in accordance with the submitted Application Data Sheet to turndown ratios as high as 1000:1. Most calibrations are performed in the actual process fluid and process conditions described by the customer's specification. Adjustment to zero and span are made easily in the field by using the keypad to input revised flow or temperature range information.

Temperature

Accuracy: ±2°F (±1.1°C). Valid only under minimum flowing conditions of 5 SFPS (1.5 NMPS).

Repeatability: ±1°F (±0.55°C).

System Approvals

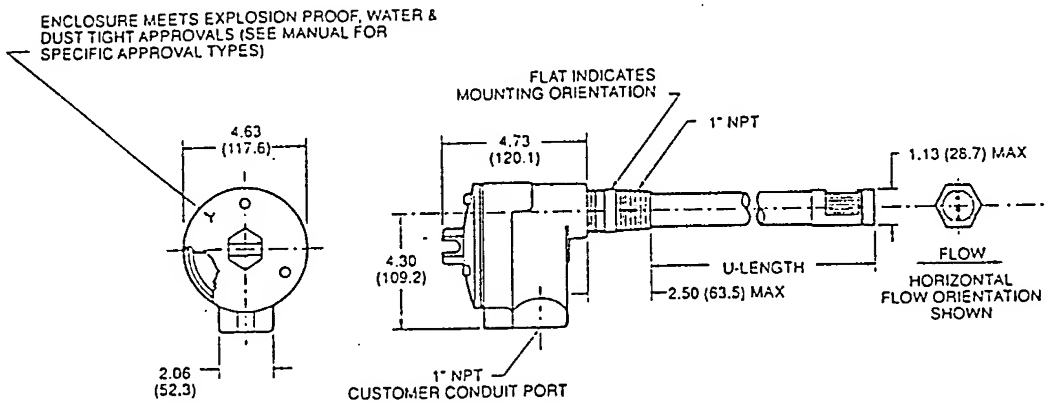
Factory Mutual Research (FM) and CENELEC†.

†GF92 FM and CENELEC approvals pending.

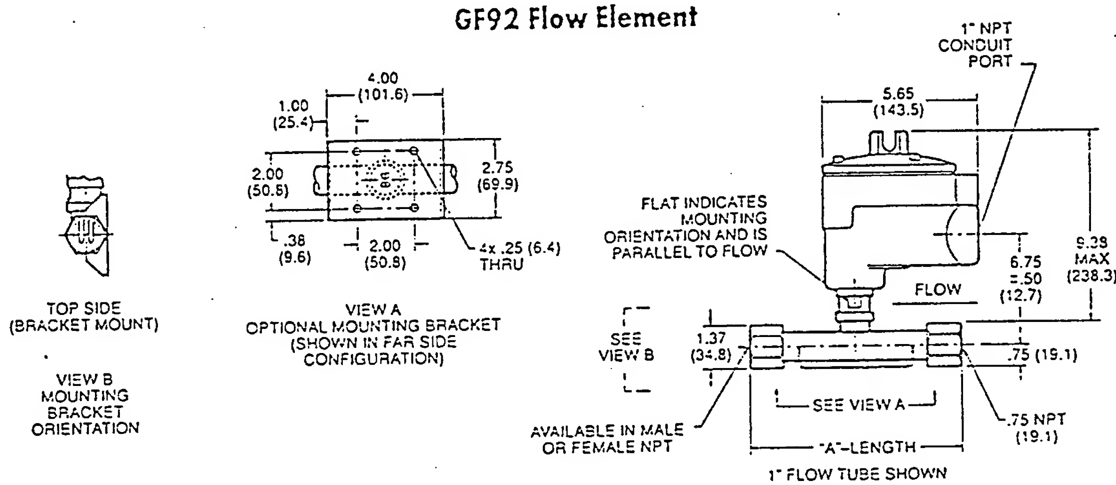
Typical GF90 and GF92 Mass Flowmetering Applications

- Flare Gas
- Combustion Air to Boilers & Furnaces
- Preheater Air to Boilers & Furnaces
- Fuel Gas -
- Scrubber Balancing
- Hydrogen Make-Up Gas
- Natural Gas Pipeline Transmission
- Compressor Fuel
- Wastewater Digester Gas or Biogas
- Process Gas
- Heavy Industrial HVAC
- Nitrogen Purge
- Landfill Vapor Recovery
- Exhaust Stacks
- Other Gas Applications. Contact FCI.

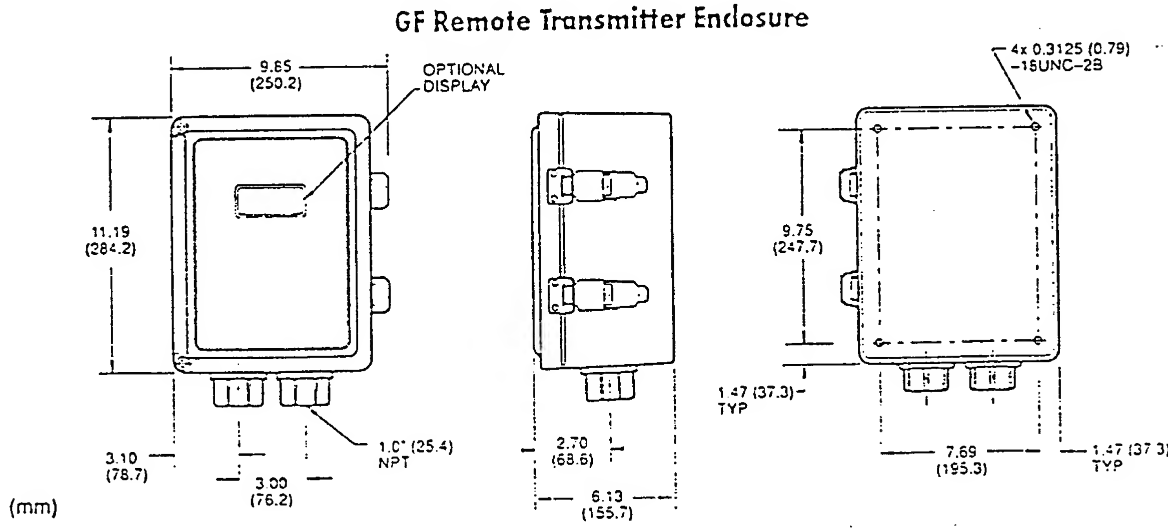
GF90 Flow Element



GF92 Flow Element



GF Remote Transmitter Enclosure



Two independent analog outputs can be set in the field. Modes include 4-20 mA, 0-10 VDC, 0-5 VDC, or 1-5 VDC. Process flow rate, temperature and all GF Series functions are simultaneously available through the RS-232C and RS-485 serial ports.

Smart Features Outstanding features of FCI's GF Series microprocessor-based electronics include:

User-Friendly Operation and Maintenance. Start-up, verification and operation are easily performed through the friendly menu-driven display.

Indicator Display. Four lines by twenty character liquid crystal display indicates flow rate, total flow, temperature, switch point status, current calibration mode and sample rate. Flow rate, total flow and temperature can be independently set to English or Metric (SI) units.

In-Field Programming. The built-in keypad permits easy touch, in-field programming to change zero, span, switch points, units of measurement, instrument verification, trouble shooting and other critical instrument functions.

Built-In Testing & Diagnostics. Built-in testing and diagnostic capabilities ensure accurate and reliable performance. Diagnostics include out of range detection and forced output.

Non-Volatile Memory. Non-volatile memory prevents the loss of valuable application data and totalized flow due to loss of power.

Security. Pass-code protection offers security against both unauthorized access and equipment tampering.

Multiple Calibration Groups. Up to three calibration groups can be stored in a single GF Series transmitter. Each group can be independently configured for a specific calibration range, media, switch point settings, etc. For example, a hydrogen line that requires periodic purging with nitrogen gas can be measured with a single GF Series Mass Flowmeter. The complete calibration data for each gas can be stored in one of the three available groups. Each calibration group can be manually or automatically selected to provide an accurate indication of a specific process gas.

The three calibration groups can also be utilized to enhance or preserve accuracy over wide flow turndowns. Accurate flows with turndown ratios of 1000:1 are possible through group linkage. In addition, automatic switching between groups can also be controlled by process temperature variations.

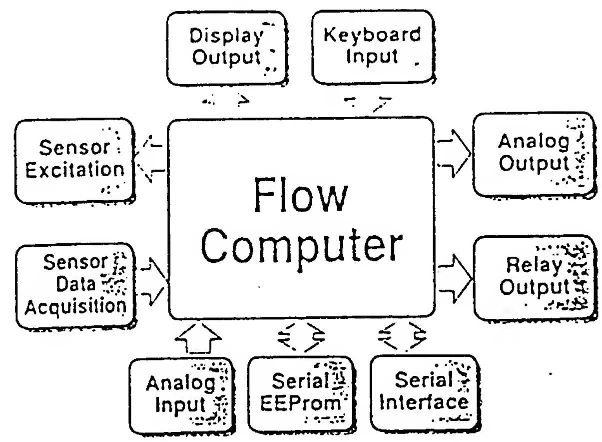
Auxiliary Input Terminal. An auxiliary input terminal is available for connection to an external signal source providing real-time compensation. Composition analyzers, pressure and temperature transducers, densitometers, etc. can provide correction through the auxiliary input terminal. This terminal also provides a method for remotely switching between calibration groups.

System Approvals. Local flow element and remote transmitter enclosures that meet hazardous location explosion-proof protection are available. Agency system approvals for FCI's GF Series Mass Flowmeters include Factory Mutual Research (FM) and CENELEC†. Other agency approvals are available for special applications.

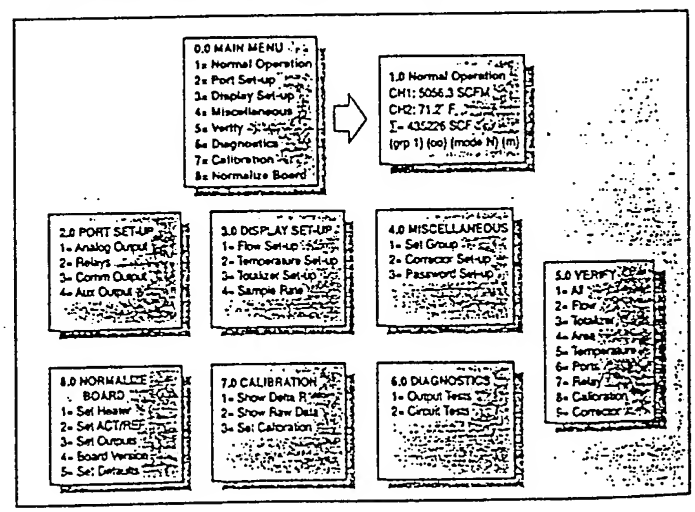
A NEMA-type 4X transmitter enclosure is standard with a NEMA-type 7(BCD) local enclosure for remote transmitter applications. An optional NEMA-type 7(CD) transmitter enclosure is also available.

† FM and CENELEC approvals pending

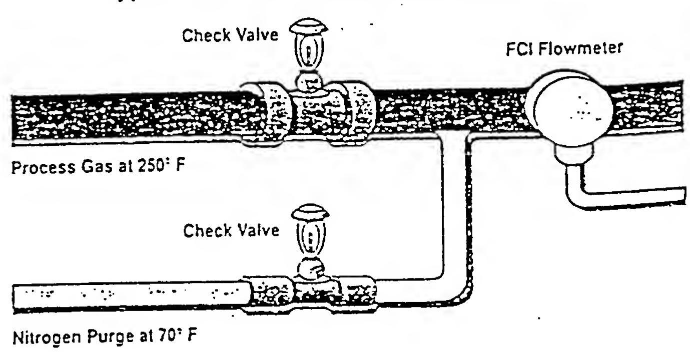
GF Series Top Level Block Diagram



GF Series User-Friendly Menu Structure – First Level



Typical Multi-Calibration Group Application



FCI's Instrument User's Protection Plan

Guaranteed Performance. FCI guarantees performance of its entire product line — including mass flowmeters, flow switch/monitors and liquid level interface controllers – in accepted applications or your money back.

3-Year Warranty. FCI products are warranted against faulty materials or workmanship for three full years from the date of delivery to the buyer. (Ask for a copy of our complete warranty.)

Customer Service. FCI commits itself to providing prompt customer service including expedited field service and repair support, and toll-free factory service.

Why LEDs?

An Introduction and Comparison

LEDs have reached the current state-of-the-art through years of experimentation with materials and processes. The result is an inexpensive, long-lived and energy-efficient point-source of light that is available in all of the standard signal colors.

LEDs are essentially **monochromatic**. They tend to emit light in a very narrow set of wavelengths grouped around a peak. It is this peak wavelength (see Figure 1.) that describes their color. Because they don't waste a lot of energy pumping out light at many frequencies (like a 'white' incandescent lamp does), they are **much more efficient** at converting electricity into **usable** light.

This narrow range has another bonus for traffic applications. The eye is more sensitive to yellow-green light than any other.* Since the LEDs operate from 555 nanometers (green) to 660 nanometers (red), we find this yellow-green area (around 563-565) conveniently tucked in-between. Simply put, the LED has to work less hard around the signal colors (less wattage used, more money saved), because humans perceive these colors at slightly lower intensities than, say, blue or violet. Since the color of an LED is 'built-in', not filtered-out as in an incandescent signal, **manufacturers can tailor the LED to use less current** at the wavelengths that happen to be in our signal color range and still get the same **apparent** brightness.

LEDs differ from tungsten lamps in important ways:

LIFE: LEDs have a useful life of around **100,000 hours**, or over 10 years. This is **several magnitudes greater than incandescent lamps**. Tungsten lamps are prone to failure due to thermal shock and vibration, conditions that have little or no effect on LEDs. Tungsten lamps depend on a fragile glass envelope filled with inert gas, LEDs are encapsulated in solid resin, **sealed from environmental moisture and contaminants**.

CONTROL: High amperage switching systems for incandescents can become cumbersome and costly. Control of low-current LEDs can be implemented with integrated circuits. Reliability improves with long-lived solid-state IC's vs electromechanical relays and timers. Power to operate and control LEDs can come from **solar sources** as well. since LEDs are essentially low power DC devices.

EFFICIENCY: **Tungsten lamps are incredibly inefficient light sources.** Indeed, they are better furnaces than they are illuminators, since fully **95% of the energy expended is radiated as heat** and not light (see figure 2.). Since we are not blessed with vision that extends into the infrared, we need light sources that emit efficiently in the visual portion of the spectrum. **LEDs emit cold light** at narrow and precise wavelengths, yielding the most useful colors and radiating no waste heat. With no filament to heat, they switch **much faster** than tungsten lamps as well.

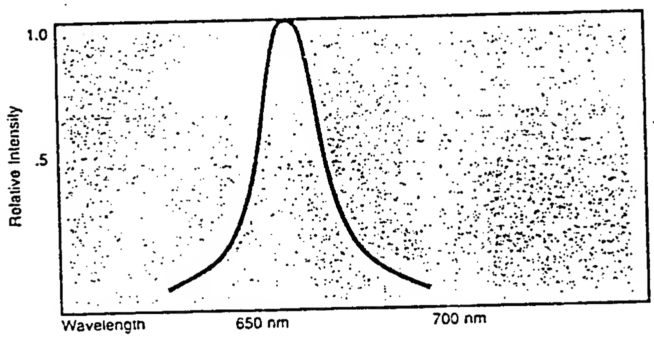


Figure 1. Typical spectral distribution of LED at 660 nm. Note the peak at the specific wavelength, and the rapid fall-off.

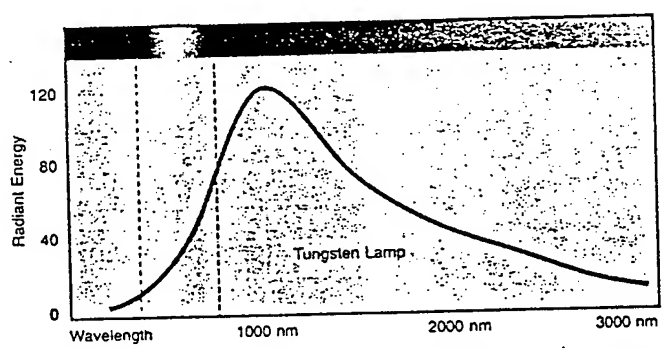
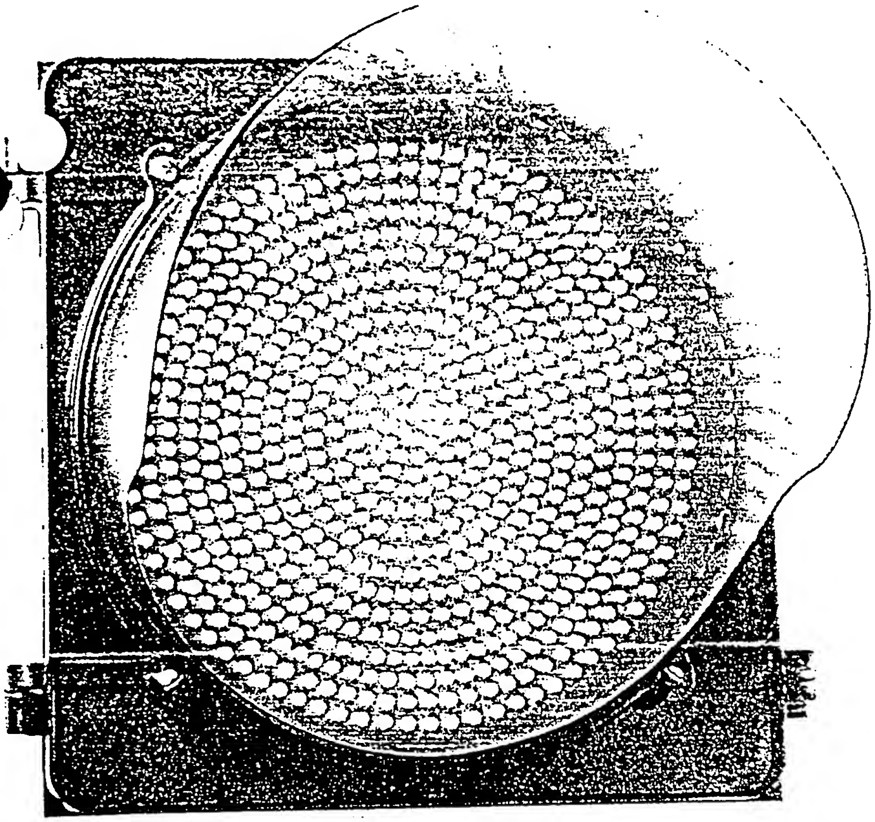


Figure 2. Tungsten lamp radiating at 3000 deg. K. Very little energy falls within the visual region, most is in the infrared.

LEDs are your best choice for bright, energy-efficient signals and signs.

* See accompanying article *The Eye and the Measurement of Light*



12" Red LED Traffic Head

LEDs... The Efficient Answer to Power-Hungry Incandescent Traffic Signals

USES ONLY 20 WATTS!*

- Patent-pending circuitry for high brightness during brownouts
- High-efficiency, high-output LEDs
- Watertight gasket surrounding unit
- Excellent for retrofit into existing housings or new installations
- Engineered for long life
- Impact resistant polycarbonate lens
- 5 year limited warranty
- 18 gauge heavy-duty cord
- Complete unit; installs with only a screwdriver
- Begins to pay for itself through energy savings immediately
- Qualifies for energy-reduction grants and rebates from utilities †

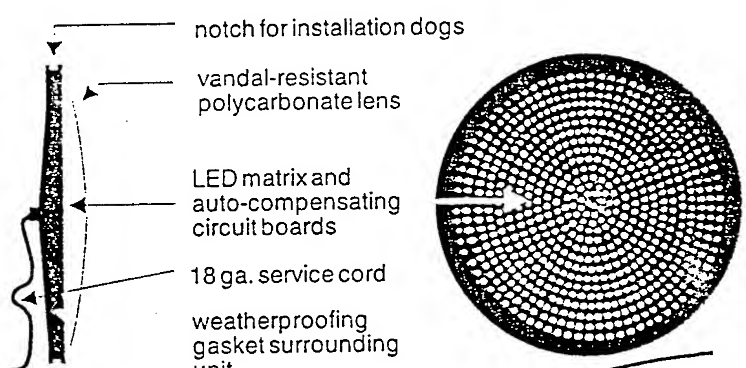
Operating Voltage: 85 to 125 VAC Auto-compensating for changes in line voltage

Power Consumption: 20 (+ or - 2) watts

Lens: Impact-resistant clear or red-tinted polycarbonate

Gasket: Provides weatherproofing and mounting, ethylene propylene diene monomer (EPDM)

LEDs: High-efficiency red



Specifications for 12" Red LED Traffic Head

Electro-Tech's

1230-M North Jefferson St. Anaheim, CA 92807 Phone: 714-630-3011 Fax: 714-666-1459

In Canada Phone: 905-764-1796 Fax: 905-764-2991

* (+ or - 2 watts)

† Availability of loans, grants, or any awards are at the sole discretion of the utility or awarding agency. It cannot be implied that installation of these LED heads in any way automatically results in any award. Applications made to utilities and agencies are subject to available funds, and the review criteria of the utility or agency involved.

APPENDIX E: COMMENTS AND RESPONSES

APPENDIX E

COMMENTS & RESPONSES

Pre-Final Review
Comments & Responses

Project Review Comments		
	Interim ☐ Pre-Final √ Final ☐	Project: UMCS Feasibility Study Pre-Final Report Location: Fort Campbell, Kentucky Year: P.N.

Reviewer: R. W. White, Jr. Huntsville C.O.E

Page: 1 of 2

Name:

Date: Dec 31, 1995

Organizer:

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. √ Mech. ☐ Elec. ☐ San. ☐ Env. ☐ Fire ☐ Other	Action Code	RESOLUTIONS (include location of documents)	Ref.
1			Gen.	Overall, this submittal is much improved from the previous. However, deficiencies and serious concerns still exist, mainly the level of engineering effort and accuracy of the results.		No comment required.	
2			Gen.	The 60% Interim Review comments took issue with the engineering methodology and the credibility of the results. Specifically, additional field measurements were requested to substantiate the broad assumptions which now appear to be just statements of fact. This concern has not been adequately addressed. No data is present in the revised field notes that relate to air flow. The CFM value used is still either 20 percent or 5 percent of gross square footage area. In fact, upon further comparisons of field notes and spreadsheet values, many huge discrepancies are noted in the square foot data (i.e. Page C-70 says Building 5470 has 14,173 square feet and 2 floors, but the survey sheet shows 50,000 square feet and 1 floor). And why go to 5 percent outside air design in the hangars where fresh air standards are stiffer?	A	See our response to comment #3 by Anthony W. Battaglia. Discrepancies exist in raw field note data and actual building square footage because real property data regarding square footage was used in calculations; whereas, raw field note data is just a guess as far as square footage is concerned. Five percent of the outdoor air goes to the office portion of the hangars based on 25% of the building's square footage being office and 75% hangar. Thus, 5% of the total of 20% outside air entering the hangar is in the office area.	
3				The assumptions used in the temperature setback calculations are too broad throughout your study to establish credible results. How can you use the same R-value for every roof? And the same R-value for every wall? Substantial differences in the array of construction exist.	A	As stated in the report and earlier comments, substantial differences do not exist in the construction of the buildings under survey.	
4				Please expand the description of ECO 1 (especially the reduced outside air one) to include a sample calculation for an actual building where values can be traced for each subpart as applicable. (The sample calculation for savings from outside air reduction on Page C-75 is the wrong one.) Include the value(s) used in the calculation for the average bin temperature of the unoccupied hours.	A	See Pages 3-26 through 3-37 for sample calculations. The calculation on Page C-75 is not a sample calculation. It is the savings calculation for flight simulation buildings that was requested at the Interim Review.	

E-A

ACTION CODES:
A - Accepted/Concur D - Action Deferred N - Non-concur VE - VE Potential/VEP Attached W - Withdrawn

Project Review Comments	Interim ☐ Pre-Final √ Final ☐	Project: UMCS Feasibility Study Pre-Final Report Location: Fort Campbell, Kentucky Year: P.N.	Reviewer: R. W. White, Jr. Huntsville C.O.E Name: Organizer:	Page: 2 of 2 Date: Dec. 31, 1995

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. √ Mech. ☐ Elec. ☐ San. ☐ Env. ☐ Fire ☐Other	Action Code	RESOLUTIONS (include location of documents)	Ref.
5				Explain how the system will save energy on reduced outside air in the barracks where each room is only served by a fan coil unit. Verify size and number of air handlers.	N	The calculation is for reduced infiltration in barracks due to shutting off general exhaust fans. There are no air handlers in these buildings.	
6				The results on the spreadsheet for savings due to reduced outside air appear to be a function of square footage only. All the other variables become constants for that particular group. It appears you grouped buildings together on the same spreadsheet that have different unoccupied schedules. Again, this is not realistic and your own survey forms show the discrepancy in hours of operation for grouped buildings.	A	While the hours of occupancy do vary slightly from building to building (i.e., 7 a.m. to 5 p.m., 8 a.m. to 6 p.m.), the buildings are grouped by type of occupancy - barracks, administrative, etc. Since occupancy times are not set in stone, buildings of the same occupancy type which are occupied during the same general hours were grouped together.	
7				Looks like you are missing some data on C-67 and C-69 under "Electric Savings $/yr".	A	Missing values are "0" and have been inserted.	
8				The savings are still reported down to the penny. Quite a stretch.	A	This has been corrected.	

ACTION CODES:
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Project Review Comments	Interim ☐ Pre-Final √ Final ☐	Project: UMCS Feasibility Study Pre-Final Report Location: Fort Campbell, Kentucky Year: P.N.	Reviewer: Anthony Battaglia Name: CESAM-EN-DM Organizer:	Page: 1 of 4 Date: Dec. 31, 1995

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. √ Mech. ☐ Elec.	Action Code	RESOLUTIONS (include location of documents)	Ref
1			Gen.	Although some improvements have been made over the Interim Report, this study is still not acceptable. Recommend acceptance be withheld until all comments have been satisfactorily addressed.	A	As discussed at Pre-Final Review, a preview of response and action taken on Pre-Final comments will be forwarded for approval prior to Final Report submittal.	
2			Gen.	Comments 3-9 apply to responses to Battaglia's Interim comments. 1C Interim Comment.	A	No response necessary.	
3			1C2	The revised field survey forms are not much better than the originals. Is it possible that we were sent the wrong package?	A	As discussed at the Pre-Final Review, the Field Notes are in raw form. Systems Corp has added documentation regarding other sources of information for buildings and equipment data in *Section 3.1*	
4			IC8	The response referenced Life Cycle Cost Analyses (LCCIDs) for Projects 1A and 1B. The referenced LCCIDs could not be found.	A	This was an error on our part in the response to Interim Review comment #8. Only one LCCID should be referenced for Project 1. There is no Project 1A or 1B.	
5			IC13	Comments regarding barracks occupancy: The response to this comment does not agree with the revised narrative. The narrative could probably be corrected very easily.	A	The narrative has been corrected.	
6			IC18	For Part A of the original comment see Comment 5 above. For Part B of the original comment, the totals for the DAY BIN DATA in Table 3.2.2.1 are still incorrect.	A	The numbers shown in the table are incorrect. However, since the average and weighted bin data was not used in the calculations, the table has been deleted entirely.	
7			IC20	The response to the comment regarding the use of 20% as the OA quantity refers the reader to the revised field notes. There still is no supporting data in the field notes.	A	See *Section 3.1* regarding documentation of sources of information which could not be obtained from raw field notes.	
8			IC21	The comment was on the dividing of the buildings into three zones and the response referred the reader to the revised field notes. Still cannot find the referenced material in the field notes.	A	See Comments #3 and #7.	
E-C 9			IC23	The response says, "....See backup data provided in support of calculations and assumptions..."; it also says, "See.....Field Survey Notes for explanation of chiller efficiencies found in the field." There is still no supporting data in the field notes.	A	See *Section 3.1* regarding documentation of other sources of information for data which could not be obtained in the field.	

ACTION CODES:
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Project Review Comments	Interim ☐ Pre-Final √ Final ☐	Project: UMCS Feasibility Study Pre-Final Report Location: Fort Campbell, Kentucky Year: P.N.	Reviewer: Anthony Battaglia Name: CESAM-EN-DM Organizer:	 Date: Dec 31, 1995

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. √ Mech. ☐ Elec.	Action Code	RESOLUTIONS (include location of documents)	Ref
10			2-6	In the narrative, please include an explanation of the Network Interface Module shown at the top of *Figure 2.4.3.1.1.*	A	See revised narrative, *Section 2*, for explanation of network interface module.	
11			2-8	Para. 2.4.3.4.1: With regard to the four computers mentioned, this does not agree with the narrative on Page 2-5. Please correct.	A	Narrative has been revised on Page 2-8.	
12			2-10	Para. 2.4.4: The first sentence is beginning to sound like a sales pitch. Please revise in a more objective manner.	A	Sentence has been deleted.	
13			3-1	Please add, just above para. 3.1.1, something like, "The Economic Analyses for these ECOs begins on page 3-24."	A	See revised narrative, Page 3-1.	
14			Sect. 3	Define the heating and cooling seasons, ie, which months?	A	See Page 3-25 for revised narrative discussing heating and cooling season breakdown.	
15			3-18	In the first complete sentence, it states: "...chillers are monitored for energy savings...and also for maintenance savings..." The system does not monitor savings. It monitors temperatures, status, and other conditions which can be used to produce savings. Please revise.	A	Narrative has been revised. See Page 3-18.	
16			3-25	The revised wording regarding barracks occupancy does a good job of explaining the problem. Now, just add a sentence or two to explain why you chose the hours you did.	A	See Page 3-25 for revised narrative.	
E-D 17			3-25	Para. 3.2.2.1: Regarding outside air quantities, please see Comment 7 above.	A	See Page 3-25, *Section 3.2.2.1* for documentation of assumptions regarding outdoor air quantities.	

ACTION CODES:
A - Accepted/Concur D - Action Deferred N - Non-concur VE - VE Potential/VEP Attached W - Withdrawn

Project Review Comments	Interim ☐ Pre-Final √ Final ☐	Project: UMCS Feasibility Study Pre-Final Report Location: Fort Campbell, Kentucky Year: P.N.	Reviewer: Anthony Battaglia Name: CESAM-EN-DM Organizer:	Page: 3 of 4 Date: Dec 31, 1995

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. √ Mech. ☐ Elec.	Action Code	RESOLUTIONS (include location of documents)	Ref
18			3-27	The equations shown are easy enough to understand, but there are no examples of how they were used to obtain the reported savings. In trying to reproduce the results, I went through the following example: I used the equation at the top of Page 3-27 and bin data from TMS-758 (for each month of the cooling season and each unoccupied time period) to calculate summer savings for outside air reduction for Building 3672. See attached hand calculations. The result was a savings of approximately 21 MBtu/yr, 50 percent higher than the reported value on Page C-70 of 14.6 MBtu/yr. I also calculated these same savings using the data from Table 3.2.2.1 (with the corrected average temperatures). And obtained 15.8 MBtu/yr, reasonably close to the reported value of 14.6 MBtu/yr. The moral of all this rambling is that bin data is already averaged data. Averaging it again, just gets you farther away from an hour-by-hour analysis. Let's discuss either using computer simulations for typical buildings, as recommended in the Interim Review, or doing a "true" bin method.	A	See Pages 3-26 through 3-27 for sample building calculations.	
19 E-E			3-27	Statements are made regarding the efficiency of chillers, boilers, and distribution systems. Deleting the word "assumption" does not change these from being assumptions. But there is nothing wrong with making assumptions if they are reasonable or if backup is provided. As stated in Comment 8 above, no backup can be found in the field data. The assumptions are not unreasonable. Certainly some logical basis can be found and quoted to support them.	A	See revised narrative on Page 3-1 through Page 3-37 indicating sources of assumptions regarding these efficiency figures.	

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Project Review Comments	Interim ☐ Pre-Final √ Final ☐	Project: UMCS Feasibility Study Pre-Final Report Location: Fort Campbell, Kentucky Year: P.N.	Reviewer: Anthony Battaglia Name: CESAM-EN-DM Organizer:	Page: 4 of 4 Date: Dec 31, 1995

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. √ Mech. ☐ Elec.	Action Code	RESOLUTIONS (include location of documents)	Ref
20			C-75	Energy Savings Calculations for Flight Simulators: These calculations apparently assume that the chillers will be working at full load even when the simulators are not in use. This is not a realistic assumption. Please redo or provide more information.	N	The assumption used is for chillers running at 50 percent load.	
21			E-16	In the analysis using the DOE model, why weren't the other electricity savings of 16.8 MBtu/yr (208.58 -191.78) used?	A	These savings should have been added to the simulated building's energy savings. See revised DOE 2 simulation, *Appendix E*.	
22			3-29	The U values used for roofs and walls should be backed up somehow, by a calculation based on the as-built condition, or by a typical section out of an ASHRAE manual (compared to the real thing of course). The values used in the DOE runs (wall + glass) are significantly different. Why?	A	This was an error in the input data of the DOE2 simulation. See revised DOE2 simulation input and output data, *Appendix E*.	
23			3-29	An equation is provided for annual summer savings. There should be one for annual winter savings as well. Please include.	A	See Pages 3-26 through 3-37 for equations used and sample building calculations.	
24			3-29	The equation provided for summer savings used two ΔT's, 5F and 10F. Why? If you are doing a bin data calculation, calculate all the UA ΔT's for each time period and sum them up!	A	See explanation of where 5 and 10 degree ΔT's come from on Pages 3-33 through 3-35.	
25			3-30	Don't they have as-built drawings that you can use to determine wall areas?		As described in the narration, as-built drawings were generally unavailable. In instances where this was the case the method described in this section was utilized for determining wall areas.	

ACTION CODES:
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Project Review Comments	Interim ☐ Pre-Final √ Final ☐	Project: UMCS Feasibility Study Pre-Final Report Location: Fort Campbell, Kentucky Year: P.N.	Reviewer: Charles Lockman Name: CEORL-ED-MS Organizer:	Page: 1 of 1 Date: Dec. 31, 1995

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. √ Mech. ☐ Elec. ☐ San. ☐ Env. ☐ Fire ☐Other	Action Code	RESOLUTIONS (include location of documents)	Ref
1		5.0	5 - 2	*Table 5.1.1* - Asterisk symbol needs to be footnoted as to what it means, although Page 5-6, 5.3.2 explains it. A quick footnote would work great, and because the table precedes the actual explanation.	A	The footnote has been added to table.	
2			Page 7-3	*Table 7.1.1* - Description of Sewage Lift Station was omitted. If it has a known name, it should be named or identified for the UMCS/SCADA operations of that unit.	A	Description of lift station has been added in column #1 of *Table 7.1.1*.	
3			Page 8-1	Para. 8.2.1 - Are the reimbursable customer sites added up correctly at 64 sites? Combining the electric and gas metering, do those all add up to 64 sites? Just checking it out.	A	There are a total of 64 sites. All 64 sites have electric service, only 41 sites have natural gas service.	
E-G							

ACTION CODES:
A - Accepted/Concur D - Action Deferred N - Non-concur VE - VE Potential/VEP Attached W - Withdrawn

Mr. Battaglia's
Additional Review
Comments &
Responses

Project Review Comments			
Interim ☐	Project: UMCS Feasibility Study Pre-Final Report	Reviewer: Anthony Battaglia CESAM-EN-DM	
Pre-Final √	Location: Fort Campbell, Kentucky	Name:	Date: Jan. 5, 1996
Final ☐	Year: P.N.	Organizer:	

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. √ Mech. ☐ Elec.	Action Code	RESOLUTIONS (include location of documents)	Ref .
1			3-1	Correct spelling of "Outside" in heading.	C	Typo has been corrected.	
2			3-1	Why aren't weekends included in the unoccupied times? Include or explain why they cannot be included.	C	Savings can be achieved through temperature set back / set up and air flow reduction during the weekends in unoccupied buildings. See *Section 3* for derivation of energy savings equations, including unoccupied weekend hours.	
3			3-2	Correct enthalpy in fourth line of *Table 3.2.2.1.*	C	Typo has been corrected.	
4			3-2	Appears the last number in the derivation of *Equation 1* should be 185 instead 1.85.	C	Typo has been corrected.	
5			3-3	Derive the constant for *Equation 3.*	C	The constant is derived and an algebraic error made in the original derivation is corrected.	
6			3-3	Correct spelling of "quantity" below *Equation 4.*		Typo has been corrected.	
7			3-3 & 3-4	The sample calculation is O.K., but the approach is not realistic. This assumes, that in the current mode of operation, the OA dampers are open even when the OA temperature is 8 degrees below zero. No one operates their HVAC equipment that way for long; they would freeze the coils! This has to be tempered with some common sense. Perhaps you should assume that the OA dampers could be open down to the temperature at which the freezestats are set, normally about 35 °F.		This is not the case. The outside air dampers are fixed, as is commonly done. The freezestat measures <u>mixed</u> air temperature prior to entering the coils, which consists of outside air and return air. For example, the mixed air temperature when outside air is -8°F and return air is 57°F is: -8°F (.20) + 57°F (.80) = 44°F Thus 44°F is the lowest possible temperature the freezestat would see. The freezestats are set at 38°F for shutdown of equipment.	
8			3-4	Equation 6: Please show the derivation of the constant, keeping in mind the comment above. Also, discuss how the CFM reduction will be obtained for the barracks, realizing that they use individual fan-coil units. Please see comment No. 15 on page 2.		See responses to comments #7 and #15, and revised narrative of *Section 3.*	
E-H 9			3-6	Two questions regarding the calculation of the U-value for the outside walls: A. The R-value shown for concrete block is 2.1 The ASHRAE Fundamentals Handbook shows this value for concrete blocks with the cavity filled with Perlite insulation. Just plain 8" concrete block has a value of 1.11. Should it be changed? B. Gypsum board is listed directly after concrete block. I doubt that the gypsum board is glued directly to the block. Usually there are furring strips, creating an airspace with or without insulation. Please check on the actual condition and correct as needed.		A. The block cavity is filled with Perlite insulation and has an R-value of 2.1. The description in the derivation has been corrected. B. The gypsum board is attached with furring strips which create a 3/4" air gap. The determination of the wall U-value has been corrected to include the thermal resistance added by the air gap.	
10			3-6	Please list the components and R-values of the roof/ceiling assembly.	C	The components of the roof/ceiling assembly is shown in the derivation of the roof U-value.	

ACTION CODES:
A - Accepted/Concur D - Action Deferred N - Non-concur VE - VE Potential/VEP Attached W - Withdrawn

Project Review Comments	Interim ☐ Pre-Final √ Final ☐	Project: UMCS Feasibility Study Pre-Final Report Location: Fort Campbell, Kentucky Year: P.N.	Reviewer: Anthony Battaglia Name: CESAM-EN-DM Organizer:	Page: 2 of 2 Date: Jan. 5, 1996

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. √ Mech. ☐ Elec.	Action Code	RESOLUTIONS (include location of documents)	Ref
11			3-7	The inside temperature before setup (inside design temperature?) and inside design temperature after setup are discussed without ever mentioning the actual values, just that the setup would be 10°. Page 3-29 of the prefinal submitted states that the unoccupied summer setpoint is 82°F. This would mean that the inside design temperature is 72°F, which is not consistent with Army policy. TM5-810-1 sets a range of 75 to 78°F for the cooling inside design temperature. I would recommend using 77°F since it would be convenient for the bin calculations.	N	Existing summer setpoint is 72°F as stated in the report, based on actual conditions, not design conditions.	
12			3-8	In the text in the center of the page, you say that *Equation 10* should be multiplied by the number of hours. Note this should be UNOCCUPIED hours.	C	Has been corrected.	
13			3-6 thru 3-9	I could not readily follow the derivation of the equations for unoccupied setback savings, so I did my own bin data calculation (attached) and got much lower summer savings for Bldg 3672. In trying to find out why there was such a big difference, I substituted the hours from my calculations into your equation on page 3-9 and got almost the same results, i.e., 10,998,250 compared to 10,997,699. Is it possible that the wrong hours were used in the calculation on page 3-97. How did you come up with 395 hours for 5° ΔT and 279 for the 10°ΔT?	C	The number of hours that savings can be achieved are based on an initial set point of 72 degrees and a set up temperature of 82 degrees. This would include savings for 395 hours/year in the 75-80 degree bin and 279 hours/year in bins greater than 80 degrees. The equations have been revised to include weekend unoccupied hours. (See response to Comment 2.)	
14			3-9	Check hours used for Bldg. 3672 winter savings. Correct as needed.	C	Has been corrected.	
15			General	I still cannot accept a flat assertion that all of the buildings have 20 percent ventilation air. The barracks in particular are suspect since they use the individual fan-coil units. Please physically check out some of the barracks buildings, determine what means are used for ventilation, and provide a calculation (based on the number, size, and capacity of the actual ventilation devices) for the ventilation rate. Then determine, based on the types of ventilation devices, if it is technically feasible to shut off or reduce the outside air with the UMCS. Then provide a sample calculation and determine the savings.	C	A site visit was conducted on December 21, 1995, which indicated the outside air flow percentage to be 22 percent in a typical barracks. The assumption of 20 percent is off by 10 percent in the conservative direction; therefore, we stand behind our assumptions.	

ACTION CODES:
A - Accepted/Concur D - Action Deferred N - Non-concur VE - VE Potential/VEP Attached W - Withdrawn

Interim Review Comments & Responses

Project Review Comments	Interim √	Project: UMCS Feasibility Study Interim Report, 60 Percent	Reviewer: Charles Lockman	Page: 1 of 1
	Pre-Final ☐	Location: Fort Campbell, Kentucky	Name: CEORL-ED-MS	Date: Sept. 25, 1995
	Final ☐	Year: P.N.	Organizer:	

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. √ Mech. ☐ Elec. ☐ San. ☐ Env. ☐ Fire ☐Other	Action Code	RESOLUTIONS (include location of documents)	Ref
1		5.0	5 - 1	Emergency Generators: Last sentence "especially the larger units," should the sizes be determined as to what are larger units that would be available to be tied into the SCADA system? Not everyone knows what determines the larger units by identification--just to know the breakpoint smaller-larger.	A	Concur. See revised portion of Par. 5.1, Page 5-1.	
E-1							

ACTION CODES:
A - Accepted/Concur D - Action Deferred N - Non-concur VE - VE Potential/VEP Attached W - Withdrawn

Project Review Comments	Interim √ Pre-Final ☐ Final ☐	Project: UMCS Feasibility Study Interim Report, 60 Percent Location: Fort Campbell, Kentucky Year: P.N.	Reviewer: Ronald L. Pepper Name: CEORL-ED-DE Organizer:	Page: 1 of 4 Date: Sept. 25, 1995

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. √ Mech. ☐ Elec. ☐ San. ☐ Env. ☐ Fire ☐Other	Action Code	RESOLUTIONS (include location of documents)	Ref.
1			General	The UMCS system, as described, will be a valuable tool for the installation. Due to the wide range of operations that can be done at the console, levels of security and who is authorized to do what should be considered carefully. Possibly, for some operations, the operator would have to contact someone at the respective department so that they could enter an access code in order for processing to take place. Operations concerning the traffic signals and power systems would be the most likely to require extra authorizations.	A	Concur. The software package has a multi-level password protected access feature. See *Section 2.4.3.5.2.*	
2			General	I noticed several "not in service" items in the substations and some "no communication" items in the EMCS list with no explanations. Why? I assume that the substations are functional, but not required to current demand. Are the EMCS items off-line due to DTM, headend, FIDs/MUXes, sensors, a mixture of all, a future connection, or just turned off?	A	Concur. See *Section 2.2*, Page 2-1, where the operating condition of the existing EMCS system is described.	
3		2.4.3.5.2		Facility HVAC Systems: The "info" to be supplied with the alarms sounds great, but some parts of the database, especially the critical/noncritical breakpoints and the "troubleshooting guide," would have to be developed over a considerable period under the control of a knowledgeable operator.	A	Concur.	

ACTION CODES:
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Project Review Comments	Interim √ Pre-Final ☐ Final ☐	Project: UMCS Feasibility Study Interim Report, 60 Percent Location: Fort Campbell, Kentucky Year: P.N.	Reviewer: Ronald L. Pepper CEORL-ED-DE Name: Organizer:	Page: 2 of 4 Date: Sept. 25, 1995

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. √ Mech. ☐ Elec.	Action Code	RESOLUTIONS (include location of documents)	Ref
4			2.4.3.5.2.1	Non-critical alarms should be shown, even if they are not "reported." Some type of icon, with the "number of alarms since last review," should remain on the control screen. The operator could evaluate the alarms to decide if action is required. Alarms should remain active until they are acknowledged. Repetitive non-critical alarms should be counted. By evaluating the repetitive alarms, equipment deficiencies or operational problems can be corrected or if no real problems exist, the alarm breakpoints can be fine-tuned. Any adjustment to alarm parameters should be recorded in a revisions database that would include, as a minimum, the operator's name, changes made, reason changes made, time changes made, and a backup of the unchanged parameters.	A	Concur. The software packages generally available with the types of systems analyzed are capable of all the functions described. See *Section 2.4.3.5.2* for major software package features.	
5				Add "maintenance history" to Operator Interface block of diagram. The additional information would provide tracking of service done to equipment.	A	Concur. See revised portion of *Figure 2.4.3.5.2.1*, Page 2-10.	
6			ECO 2	Besides the items mentioned, the control system could also monitor the pressure on transformers equipped with nitrogen/inert gas systems. (Sealed and diaphragm / conservator types could probably also be monitored for leaks with pressure sensor outputs.)	A	Concur. However, the additional sensors needed to monitor transformer pressure add cost to the system without adding dollar savings, thus making the project less attractive. Since monitoring of transformer temperature will provide all necessary maintenance information, the added cost of pressure monitoring outweighs the benefits gained.	
7				Would the SCADA be used to monitor and control tie lines?	A	The system as proposed will monitor the lines. However, controlling the lines requires the addition of a motorized switch, which was not included in the estimate.	

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Project Review Comments	Interim ✓ Pre-Final ☐ Final ☐	Project: UMCS Feasibility Study Interim Report, 60 Percent Location: Fort Campbell, Kentucky Year: P.N.	Reviewer: Ronald L. Pepper CEORL-ED-DE Name: Organizer:	Page: 3 of 4 Date: Sept. 25, 1995

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. ✓ Mech. ☐ Elec. ☐ San. ☐ Env. ☐ Fire ☐Other	Action Code	RESOLUTIONS (include location of documents)	Ref.
8			ECO 3	Emergency Generators: Leak detection systems, where installed, on genset fuel tanks should be connected to the UMCS for monitoring. Fuel level deviation between run times should activate an alarm. (The deviation amount for an alarm would be adjusted on a tank by tank basis to eliminate alarms due to temperature / volume changes.) During run times, the battery voltage monitoring could help determine if the alternator was operating properly. During off times, if the voltage does not go up, i.e., battery charger function, for a few days or if the voltage goes below a given level, a "battery charger" alarm should be initiated.	A	Concur. These items have been incorporated into the project. See *Table 5.2.1.1*, Generator Metering and Monitoring Function Schedule, page 5-4.	
9			ECO 8	Athletic Field Lights: Photocells should be added to the contactor panels. Lights should be disabled during daylight hours. Maintenance can be done by using a "photocell bypass switch." A "light request" switch (momentary, push-button) should be provided for each field. Each "request" will activate the lights for a fixed period. At a preset time, say 15 minutes before the light period is to expire, an annunciator could sound or flash indicating that a new request must be entered or the lights will go out.	A	Concur. See Page 10-1 and *Figure 10.2.1* for revisions.	
10 E-4			ECO 9	Traffic Signal Lights: Consider the swap-out of the red incandescent signal lamps for the new multi-LED replacement units. According to your write-up, 15 intersections are equipped with signals. Some intersections probably have more than one signal and no mention was made of signals in front of fire stations. For 15 signal lights, a minimum of 30 red lamps will be on at any given time and the savings per lamp should be around 90-100 watts. Demand savings should be approximately 30 lamps x 90 w/lamp x 1 kW/1000W x $11.78/kW mo. X 12 mo./yr. = $381.67/yr. Energy charge savings should be approximately 30 lamps x 90 W/lamp x 1 kW/1000W x $0.0211/kWh x 24 hr/day x 365 days/yr = $499.06/yr. Total power related savings around $900/yr for the replacement of 60 lamps. Though the electrical cost savings is small, safety is enhanced. The LED retrofits have multiple lamps that, unlike the single filament incandescent lamps, continue to function if one burns out.	A	Concur. See *Section 11.3.2* for revisions incorporating these changes.	

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Project Review Comments	Interim √ / Pre-Final ☐ / Final ☐	Project: UMCS Feasibility Study Interim Report, 60 Percent Location: Fort Campbell, Kentucky Year: P.N.	Reviewer: Ronald L. Pepper Name: CEORL-ED-DE Organizer:	Page: 4 of 4 Date: Sept. 25, 1995

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. √ Mech. ☐ Elec. ☐ San. ☐ Env. ☐ Fire ☐Other	Action Code	RESOLUTIONS (include location of documents)	Ref.
11				No mention is made of "California Wire" in the control write-up. I assume that most of the lights do have the inductive loop in the pavement to sense a vehicle's presence. Sending the signals from these loops back to the UMCS could help optimize the timing schemes for items such as left turn signals.	A	Concur. See *Section 11.1* for revisions discussing the use.	
12				Miscellaneous typos and suggested rewordings: Page 2-3: Last line, first word - "Substation." Page 2-7, Par. 2.4.3.4.1: Change "the same computer" to "identical." Page 2-8, Par, 2.4.3.5.2, Second line: Change "will gives" to "give." Page 3-22, Par. 3.2.2.1, Third line: Insert a space before "table" and after "included." Page 3-27, Par 3.2.2.4: Change to read "mass" flow rate, not moss. Delete space in rate variable: lbm/m in/ton. Page 4-4, Site 2: No picture for site 2. Is there supposed to be? Page 5-1, Par. 5.1, Line 6: Change "striped" to "stripped." Page 6-4, Row 3: Data needs to be shifted left. Provide data for Col. 5. Page 8-1, Par. 8.2.1: Change "kilowatts per kilowatt hour" to "kilowatt/kilowatt hour" (per is incorrect for this case, "/" refers to dual function). Page 11-2, Par. 11.2, Second par., Line 1: Change "SACDA" to "SCADA."	A	Concur. Typo's have been corrected. See revisions on referenced pages.	
E-5							

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Project Review Comments	Interim √ / Pre-Final ☐ / Final ☐	Project: UMCS Feasibility Study Interim Report, 60 Percent Location: Fort Campbell, Kentucky Year: P.N.	Reviewer: Anthony Battaglia CESAM-EN-DM Name: Organizer:	Page: 1 of 5 Date: Sept. 25, 1995

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. √ Mech. ☐ Elec.	Action Code	RESOLUTIONS (include location of documents)	Ref
1			Gen.	Although there are some positive aspects to this report, it is not acceptable as an interim submittal. It is recommended that it be resubmitted.	W	Comment withdrawn.	
2			Field Notes	The field survey forms appear to be incomplete. This should be corrected, returning to the field if necessary.	A	Concur. See revised field survey forms.	
3	1		Table of Contents	List the Appendices in the Table of Contents.	A	Concur. See revisions to Table of Contents	
4	1		Gen.	Number all pages in appendices, As A-1, A-2, etc.	A	Concur. See revisions to Appendices.	
5	1		2-1	The statement that the existing system is "saving no energy" may be true; but insufficient backup is presented. Is any equipment being controlled with the existing system?	A	Concur. See revised *Section 2.2.*	
6	1		2-3	*Table 2.4.1*: The headings of the columns, "Elect MBTU" and NG MBTU" should be corrected to reflect that these are savings; and columns showing corresponding $ savings should be added. It may be better to orient this table horizontally rather than vertically to have enough room for all the data.	A	Concur. See revisions to *Table 2.4.1.*	
7	1		2-3	Table 2.4.1 and 2.4.2: Some of the ECOs in *Table 2.4.1*, those with SIR < 1.25, do not qualify; so you need to indicate which are recommended and which are not. *Table 2.4.2* does not indicate which ECOs are included in the overall LCCA. Also missing is any mention of adjusting savings and/or costs of the overall project as the individual projects are integrated into it (synergism). Please address this point and make corrections as needed.	A	Concur. See revisions to *Tables 2.4.1 and 2.4.2.*	
8	1		2-4	Top of page: A recommendation is made to include some ECOs which do not qualify. This is OK, but when you do this you need to perform two LCCAs, one with only the qualifying ECOs, and the other with all of the recommended ECOs. If the overall project still qualifies, the installation may be able to present justification based on safety, security, etc, and still get it funded.	A	Concur. See revisions on referenced pages and overall project LCCIDs showing *Project 1A - Recommended ECOs* and *Project 1B - Only Qualifying ECOs.*	

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Project Review Comments	Interim ✓ Pre-Final ☐ Final ☐	Project: UMCS Feasibility Study Interim Report, 60 Percent Location: Fort Campbell, Kentucky Year: P.N.	Reviewer: Name: Anthony Battaglia CESAM-EN-DM Organizer:	Page: 2 of 5 Date: Sept. 25, 1995

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. ✓ Mech. ☐ Elec.	Action Code	RESOLUTIONS (include location of documents)	Ref
9	1		2-5	Par. 2.4.3.1: Please provide an example of the physical size (or range of) of a local network. Would it serve a building? A barracks complex?	A	Concur. See revisions on referenced pages.	
10	1		2-7	Par. 2.4.3.4.1: With regard to the four computers, please indicate the proposed use of each.	A	Concur. See *Figure 2.4.4.1* UMCS/SCADA system application diagram.	
11	1		2-7	Par. 2.4.3.4.2: With regard to the sentence, "Each control module can be expanded to pick up additional points." This is governed by Corps guide specs. Have costs been estimated based on the required expansion capacity?	A	Concur. See revisions on page 2-7.	
12	1	3		In general, the HVAC ECOs investigated consist of one ECO (unoccupied shutdown or day/night setback) for all buildings except the central plants. Agreed that this is one of the best energy savers; but it is not the only thing that could be investigated. Tm5-815-2 has many energy saving routines for UMCS. One good one might be hot water temperature reset based on outside air temperature.		See response to Comment #6 by R. W. White, Jr.	
13	1	3		Analyzing unoccupied shutdown for barracks is rather risky. What hours do you consider the barracks to be unoccupied? Have you checked with the people in charge of the barracks?	A	Concur. Barracks are considered unoccupied from 8 a.m. to 4 p.m. This was verified in field survey.	

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Project Review Comments	Interim √ Pre-Final ☐ Final ☐	Project: UMCS Feasibility Study Interim Report, 60 Percent Location: Fort Campbell, Kentucky Year: P.N.	Reviewer: Anthony Battaglia CESAM-EN-DM Name: Organizer:	 Date: Sept. 25, 1995

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. √ Mech. ☐ Elec.	Action Code	RESOLUTIONS (include location of documents)	Ref
14	1	3		In studies such as this, the calculation of energy savings for UMCS applications is usually done by computer simulation of typical buildings, applying the result to other buildings of similar construction, occupancy, and mechanical systems. A base case is run to determine the existing annual energy usage of each building; and then each application can easily be analyzed by making the necessary changes in the input to the base case. The study being reviewed essentially treats all buildings the same, and uses oversimplified calculation procedures. In general, the savings calculations should be done over, starting with the choosing of typical buildings, other buildings that can be considered "similar" to the typical, and modeling of the typical buildings to obtain the base cases.	A	See response to comments #1 and #3 by R. W. White, Jr.; as well as *Appendix D* in which a typical barracks building has been modeled using DOE2.1.	
15	1		3-6	Near top of page: "The typical building contains one 7.5 horsepower pump....." The field data does not support this statement. See Comment 2.	A	Concur. See revised Field Notes and referenced pages for revisions.	
16	1		3-6	Par. 3.1.3 Par. 5A, page A-2 of the Detailed Scope of Work, mentions Link Trainers in hangars. No discussion of Link Trainers was found in the report. Please respond, add discussion as appropriate.	A	Concur. See revisions on page 3-16.	
17	1		3-20	Par. 3.2.1: Regarding the sharing of common costs among buildings: I'm not sure that this is the best method, because if a particular building does not qualify (SIR < 1.25) and you drop it, then the estimates for all the other buildings have to change. Also, HOW do you divide the common costs among the buildings? Do you just divide by the number of buildings, or is it based on the number of points in each building?		Common costs are divided based upon number of points in each building. See revision on page 3-22.	

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Project Review Comments

Interim √ Pre-Final ☐ Final ☐	Project: UMCS Feasibility Study Interim Report, 60 Percent Location: Fort Campbell, Kentucky Year: P.N.	Reviewer: Anthony Battaglia, CESAM-EN-DM Name: Organizer:	 Date: Sept. 25, 1995

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. √ Mech. ☐ Elec.	Action Code	RESOLUTIONS (include location of documents)	Ref
18	1		3-21	This comment may become superfluous based on Comment 14 above, but with regard to *Table 3.2.2.1*: A. This table is split into daytime and nighttime hours, but these don't always correspond to occupied and unoccupied hours. B. The average temperatures shown for the DAY BIN DATA should all be multiplied by two (2). Some of the average temperatures shown for the NIGHT BIN DATA look a bit low for the totals given, but that might just be rounding errors.	A	Concur. See revisions incorporating changes.	
19	1		3-22	Par. 3.2.2.1: Correct the reference to *Table 3.2.2.1*.	A	Concur.	
20	1		3-22	Par. 3.2.2.1: Assuming 20 percent of supply air to be outside air for all buildings except dining facilities and clubs is too general. Need to check as-builts, field data, occupants; and provide some type of backup.	A	Concur. See revised Field Notes.	
21	1		3-25	Par. 3.2.2.3: An assumption is made that the buildings can be divided into three blocks for the purpose of cycling the dual-temperature pumps. This cannot just be assumed; it must be verified in the field. If it cannot be achieved physically, it won't work, and we cannot take credit for the savings.	A	Concur. This has been verified in the field. See revised Field Notes for detail.	
22	1		3-27	Correct typo, "mass flow rate."	A	Concur. See revisions to referenced item.	
23	1		3-26 & 3-27	Discussion on Chilled Water Temperature Reset: The discussion delves into the intricacies of chiller technology; but in the end it proposes another assumption. Why not discuss the types of chillers being used and their ages? Provide some manufacturers or ASHRAE data to support the KW/ton at the normal setting and at the reset point. Be sure resetting can be accomplished without affecting latent capacity.	A	Concur. See backup data provided in support of calculations and assumptions. See *Section 3.2.2.4* and Field Survey notes for explanation of chiller efficiencies found in the field.	

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Project Review Comments	Interim √ Pre-Final ☐ Final ☐	Project: UMCS Feasibility Study Interim Report, 60 Percent Location: Fort Campbell, Kentucky Year: P.N.	Reviewer: Anthony Battaglia Name: CESAM-EN-DM Organizer:	Page: 5 of 5 Date: Sept. 25, 1995

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. √ Mech. ☐ Elec.	Action Code	RESOLUTIONS (include location of documents)	Ref
24	1		3-28	Par. 3.2.4, last sentence: Perhaps I missed something earlier in the report, but this reference to proposed DDC controls is the first I have noticed. This is an important part of this study, and it should be expanded upon and clarified.	A	Concur. See revisions to referenced item on page 3-28.	
25	1		4-13	Par. 4.3.1: Reference the page or table which summarizes these costs.	A	Concur. See cost estimate in *Appendix C*.	
26	1		5-6	Par. 5.3.2: Reference the page or table that quantifies demand savings, and the location of the calculations.	A	Concur. See revisions on page 5-7.	
27	1		6-1	Include distance from Boiling Springs Pumping station to the water treatment facility.	A	Concur. See revisions on page 6-1.	
28	1		6-1	2nd paragraph: Correct units for storage capacity of tanks; should be "millions of gallons," not "MGD."	A	Concur. See revisions on page 6-1.	
29	1		6-1	Last paragraph: Are the three FM transmitters mentioned existing or proposed?	A	Concur. See revisions on page 6-1.	
30	1		8-1	Par. 8.2.1: Correct "kilowatts per kilowatt hour." This refers to a demand/energy type of meter.	A	Concur. See revisions on page 8-1.	
31	1		10-3	*Table 10.3.2.1*: Correct heading of column, "Hrs/Yr Left on."	A	Concur. See revisions on page 10-3.	
32	1		11-1	Specify where the microprocessor-based controller/monitor unit is located. Do the MPs have to be involved in traffic signal light control?	A	Concur. See revisions on page 11-1. The MPs only need to be involved if traffic requires manual direction.	
33	1		11-4	I don't think anyone is going to buy the assumption of avoiding a $500,000 law suit.	A	Concur. Very difficult to quantify savings for this ECO; won't be quantified.	
E-1C 34	1		App. C	ECO-4, WATER SYSTEM CALCULATIONS: Theoretically this proposal looks good. Please provide some pump curves and VFD information to support achievable horsepower decreases.	A	Concur. See enclosed pump curve and data in Appendix C.	

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Project Review Comments

Interim √	Project: UMCS Feasibility Study Interim Report, 60 Percent	Reviewer: R. W. White, Jr. Huntsville C.O.E	Page: 1 of 5
Pre-Final ☐	Location: Fort Campbell, Kentucky	Name:	Date: Sept. 25, 1995
Final ☐	Year: P.N.	Organizer:	

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. √ Mech. ☐ Elec. ☐ San. ☐ Env. ☐ Fire ☐Other	Action Code	RESOLUTIONS (include location of documents)	Ref.
1			Gen.	Although the system proposed offers viable solutions, this report presents insufficient detail to trace numerical conclusions and utilizes questionable energy savings analysis techniques.	A	See revised, highlighted portions of entire report which provide more detailed explanations of each ECO and methods of analyses. However, the energy savings analysis techniques used have been established based on accepted engineering methods and principles. Where assumptions have been made in the analysis, they are based on empirical data developed by both Systems Corps' engineering experience and accepted authorities in the field such as IEEE and ASHRAE.	
2			Gen.	As a feasibility study, the Government expects an engineering analysis of a generic UMCS with respect to energy savings and implementation costs. With credible energy savings estimations and costs listed building by building, decisions for investment can be made. This reviewer feels that Systems Corps has failed to address the items in the SOW in sufficient detail for the Government to make these decisions.		The system analyzed is a generic UMCS system. While some specifics of certain manufacturer's systems have been referenced in the report, the overall capabilities of the system described in the report are available from a number of manufacturers. Energy savings estimations and costs have been listed where possible. For some ECOs, a building-by-building analysis is not possible or practical. Systems Corp feels that each item of the SOW was addressed sufficiently so that decisions could be made in regard to project packaging at the time of Interim Review. For example, economic analysis information provided in regard to each of the nine ECOs was sufficient to determine whether each could be a stand alone project or packaged as one larger project. While some buildings and systems analyzed may fail to meet the strict criteria for funding based on simple payback or savings-to-investment ratio, we chose to also provide a summary analysis which included all systems analyzed. In our opinion, the integral packaging of all buildings and systems analyzed makes the most sense and provides a competitive simple payback and SIR for funding purposes. For a UMCS system to be effectively practical, a large number of buildings and/or devices need to be connected to the system. This was the consensus of the government representatives present at the Interim Review meeting held at Fort Campbell on September 12 as well.	

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Project Review Comments	Interim √ Pre-Final ☐ Final ☐	Project: UMCS Feasibility Study Interim Report, 60 Percent Location: Fort Campbell, Kentucky Year: P.N.	Reviewer: R. W. White, Jr. Huntsville C.O.E Name: Organizer:	Page: 2 of 5 Date: Sept. 25, 1995

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. √ Mech. ☐ Elec. ☐ San. ☐ Env. ☐ Fire ☐Other	Action Code	RESOLUTIONS (include location of documents)	Ref.
3			Gen.	Fundamentally, the question of methodology exists. Usually some approved full-year weather-data computer simulation is employed to model baseline energy use in representative buildings, and results are extrapolated to similar buildings. The analysis here for temperature setback is faulted by limited data as all building envelope characteristics are assumed to be identical, and the only variables are wall/roof area and some delta T coupled with hours of occupancy. The field notes supplied do not indicate that an adequate survey was completed.		See response to comment #1. A computer simulation can be employed for analyses such as this. However, the SOW does not require this. The calculations used in the analysis are based on accepted engineering methods. Again, many assumptions must be made in the analyses, and the assumptions are made in a conservative fashion where possible. Even when utilizing sophisticated computer simulations, most of the same assumptions are required; in either case, the results can only be as accurate as the assumptions made. At the request of Tony Battaglia, Mobile District C.O.E., a DOE2.1 computer model of one barracks building was performed. The result of the computer simulation, using the same assumption, resulted in 15 percent higher savigs than calculations performed using spreadsheets. However, due to limitations on pump modeling inherent in the program, the spreadsheet calculations are more reliable and accurate, as well as conservative. See *Appendix D* for DOE2.1 input and output files and explanation of the savings comparison beteween the two modeling methods. In regard to the specific mention of temperature setback calculations, the only variables which need be considered are hours of occupancy, transmission losses, outdoor air temperature and air flow rates. All of these variables are considered and play a large role in determining the energy consumption and savings. We agree that the form in which the field notes were presented did not adequately present the reader with all information found in the field survey. For example, the building envelope and other data were the same for many buildings due to the fact that there is little variation in construction type at Fort Campbell. Ninety percent of the buildings surveyed were Korean War era barracks, office buildings, and support facilities constructed in like manner. The field data has been revised to present the findings more clearly.	

E-12

ACTION CODES:
A - Accepted/Concur D - Action Deferred N - Non-concur VE - VE Potential/VEP Attached W - Withdrawn

Project Review Comments	Interim ✓ Pre-Final ☐ Final ☐	Project: UMCS Feasibility Study Interim Report, 60 Percent Location: Fort Campbell, Kentucky Year: P.N.	Reviewer: R. W. White, Jr. Huntsville C.O.E Name: Organizer:	Page: 3 of 5 Date: Sept. 25, 1995

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. ✓ Mech. ☐ Elec. ☐ San. ☐ Env. ☐ Fire ☐Other	Action Code	RESOLUTIONS (include location of documents)	Ref.
4			Gen.	To assume that there is 1 CFM of air for every SF of floor space in every building and the amount of design outside air is 20 percent of that is beautifully simple. Please supply some field data and measurements to support this. Please explain the savings claimed by outside air reduction. It appears that the air handlers are already cycled off and on to maintain the unoccupied setpoint. Don't forget to consider synergism.	A	Concur. Field Notes have been revised accordingly See revised *Section 3.2.2.1* for explanation of outside air reduction calculations and impact on other calculations.	
5			Gen.	Reporting natural gas and electrical savings down to the penny implies a degree of accuracy that cannot be present with current assumptions and analysis techniques. Suggest rounding off.	A	Concur. See revised savings tables throughout the report.	
6			Gen.	The ECOs selected for analysis do not reflect the full range of energy saving possibilities for most UMCS.	A	Concur. However, for the type of buildings and systems analyzed, the ECOs proposed are the most practical and attainable for energy savings purposes. Hot water and chilled water temperature resetting controls are already in place in the local control loops of the buildings surveyed. Equipment optimization is practiced to the extent possible with existing systems, and the evaluation of replacement equipment optimization is beyond the scope of this study. The principle cause of non-attainment of energy savings through an EMCS system is the perception of interference with the occupant's ability to control his own environment. Thus, duty cycling of equipment was considered for some applications, but input derived from Fort Campbell personnel and the site survey indicate that it would not be realistic to assume that any savings would actually be attained by this method. For these reasons, scheduled start/stop of equipment was selected as the most realistic way of attaining actual savings.	
7			Gen.	No mention was made of the required analysis of previous studies.	A	Concur. See revised *Section 2.1* for references of these studies.	

ACTION CODES:
A - Accepted/Concur D - Action Deferred N - Non-concur VE - VE Potential/VEP Attached W - Withdrawn

Project Review Comments				
Interim √	Project: UMCS Feasibility Study Interim Report, 60 Percent	Reviewer: R. W. White, Jr. Huntsville C.O.E		Page: 4 of 5
Pre-Final ☐	Location: Fort Campbell, Kentucky	Name:		Date: Sept. 25, 1995
Final ☐	Year: P.N.	Organizer:		

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. √ Mech. ☐ Elec. ☐ San. ☐ Env. ☐ Fire ☐Other	Action Code	RESOLUTIONS (include location of documents)	Ref.
8			Gen.	It's hard to follow the point count for each system. It would help to include better schematics showing the control points on the equipment. Verify the number of points reported with respect to what is available from the DDC panel(s) versus what is actually an operational point. See TM5-815-2 as referenced in the SOW.	A	Concur. See Table in *Appendix C* for points list summary.	
9		1	1-1 Par. 1.1	Change "UMSC to "UMCS."	A	Concur. See revisions page 1-1.	
10		2	2-2 Par. 2.2	Please expand discussion on why the existing EMCS is "saving no energy." Describe the condition of equipment and potential for correction and/or upgrade.	A	Concur. See revisions on referenced pages.	
11		2	2-3	Bottom of page. Add "s" to "ubstations." Add "(Years)" in Table 2.4.2 after "Simple Payback Period."	A	Concur. See revisions on referenced pages.	
12		2	2-8 Par. 2.4.3.5.2	Second line down, delete the "s" on "gives." Second paragraph, second line down, delete the "s" on "displays."	A	Concur. See revisions on referenced pages.	
13		3	3-2 Par. 3.1.1	Please explain how you will implement the setback program through cycling the pumps with input from a space temperature in the barracks. Verify that there indeed exists significant unoccupied periods in the barracks. Recommend you consider taking control of the valve that controls the water temperature (if present) and reset the supply temperature according to outside temperature.	A	Concur. See revisions on referenced pages.	
E-14 14		3	3-22 Par. 3.2.2.1	Correct typo on "Outiside." Third line down, correct the confusion there: words run together and Table 3.2.2.1 is the table for the bin data.	A	Concur. See revisions on referenced pages.	
15		App C		The discrete portion name on all the life-cycle cost analysis summary sheets is HVAC. Please clarify.	A	Concur. See revisions on referenced pages.	

ACTION CODES:
A - Accepted/Concur D - Action Deferred N - Non-concur VE - VE Potential/VEP Attached W - Withdrawn

Project Review Comments	Interim √ Pre-Final ☐ Final ☐	Project: UMCS Feasibility Study Interim Report, 60 Percent Location: Fort Campbell, Kentucky Year: P.N.	Reviewer: R. W. White, Jr. Huntsville C.O.E Name: Organizer:	Page: 5 of 5 Date: Sept. 25, 1995

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. √ Mech. ☐ Elec. ☐ San. ☐ Env. ☐ Fire ☐Other	Action Code	RESOLUTIONS (include location of documents)	Ref.
16		App C		Cost estimate for 60-80 points. Missing the "Job Total" line at the bottom.	A	Concur. See revisions on referenced pages.	
17			Page 60-4	Looks like the numbers in the Midnight line got pushed over.	A	Concur. See revisions on referenced pages.	
18			7-1 Par. 7.1	Last paragraph. Suggest you rephrase the statement about the operators not reporting bypass flows.	A	Concur. See revisions on referenced pages.	
19			10-3 Table 10.3.2.1	Correct the heading in the column for hours/year left on. Check number of hours used (192 and not 280 with assumption below.	A	Concur. See revisions on referenced pages.	
20			11-4 Par. 11.3.4	The assumption of saving $500,000 from avoiding a law suit is pretty shaky.	A	Concur. See revisions on referenced pages.	
21			App. D	There is a bunch of product data upside down.	A	Concur. See revisions on referenced pages.	

E-15

ACTION CODES:
A - Accepted/Concur D - Action Deferred N - Non-concur VE - VE Potential/VEP Attached W - Withdrawn

DOE2C
MODEL ANALYSIS
RESULTS

The DOE2C computer simulation of the baseline energy use resulted in the following building energy use for Building 4053:

Heating = 925.72 MBTU/Yr
Cooling = 638.19 MBtu/Yr

A similar model used to determine the ECO energy consumption resulted in the following building energy use:

Heating = 723.96 MBtu/Yr
Cooling = 505.21 MBtu/Yr

The total heating energy saved is determined by subtracting the ECO energy use from the baseline and dividing by the generating and distribution system efficiency (75%).

$$\text{Natural Gas Savings} = \frac{925.72 - 723.96}{0.75}$$

$$\boxed{\text{Natural Gas Savings} = 269\ \text{MBtu/Yr}}$$

The total cooling energy saved is determined by subtracting the ECO energy use from the baseline, converting to tons of cooling and multiplying by 1.1 kW/ton.

$$\text{Electric Savings} = \left(638.19\ \frac{\text{MBtu}}{\text{Yr}} - 505.21\ \frac{\text{MBtu}}{\text{Yr}}\right)\left(\frac{\text{TON}}{0.112\ \frac{\text{MBtu}}{\text{Hr}}}\right)\left(1.1\ \frac{\text{kW}}{\text{Ton}}\right)$$

$$\boxed{\text{Electric Savings} = 12{,}190\ \text{kW Hr/Yr}}$$

The cost of natural gas is \$4.35/MBtu and the cost of electrical energy is \$0.02114/kW hour. The annual cost savings resulting from the ECO is:

$$\text{Cost Savings} = \left(269\ \frac{\text{MBtu}}{\text{Yr}}\right)\left(\frac{\$4.35}{\text{MBtu}}\right) + \left(12{,}190\ \frac{\text{kW Hr}}{Yr}\right)\left(\frac{\$0.02114}{\text{kW Hr}}\right)$$

$$\boxed{\text{Cost Savings} = \$1{,}430/\text{Yr}}$$

The cost savings by the bin method is \$1,208/Yr.

BASELINE MODEL INPUT

```
INPUT LOADS ..
  TITLE LINE-1 *FORT BRAGG HAMMERHEAD BARRACK* ..
  TITLE LINE-2 *BASELINE* ..
  TITLE LINE-3 *GREEN* ..

  RUN-PERIOD FROM JAN 1 1991 THRU DEC 31 1991 ..
  ABORT ERRORS ..
  DIAGNOSTIC COMMENTS NARROW ..
  LOADS-REPORT V=(LV-A,LV-B,LV-D,LV-I) S=(LS-A,LS-C,LS-D) ..

  BUILDING-LOCATION  D-S=YES  AZ=0  T-Z=5  ALT=941 ..

$ *********************** CONSTRUCTION INPUTS ***********************

  BLKWALL  = LAYERS MATERIAL=(HF-A2,HF-C8,HF-E1) ..
  WALL1    = CONS LAYERS=BLKWALL ABS=0.65 RO=2 ..
  WINDOW1  = GLASS-TYPE  PANES=1  GLASS-TYPE-CODE=9 ..
  BUROOF   = LAYERS MATERIAL=(HF-E2, HF-C5, HF-E4, HF-E5) ..
  ROOF1    = CONS LAYERS=BUROOF ABS=0.35 RO=1 ..
  FLOOR1   = CONS  U=0.5  ..

$ OCCUPANCY SCHEDULE FOR BARRACKS ROOMS
  OC-DS2   = D-SCH (1,7)(1)(8,16)(.05)(17,24)(1) ..
  OC-WEHDS2= D-SCH (1,7)(1)(8,17)(0.25)(18,24)(1) ..
  OC-WS2   = W-SCH (WD) OC-DS2 (WEH) OC-WEHDS2 ..
  OC-SCH2  = SCHEDULE THRU DEC 31 OC-WS2 ..

$ OCCUPANCY SCHEDULE FOR FIRST FLOOR DAYROOM
  OC-DS1   = D-SCH (1,7)(.1)(8,16)(.25)(17,24)(.1) ..
  OC-WEHDS1= D-SCH (1,7)(.1)(8,17)(0.5)(18,24)(.1) ..
  OC-WS1   = W-SCH (WD) OC-DS1 (WEH) OC-WEHDS1 ..
  OC-SCH1  = SCHEDULE THRU DEC 31 OC-WS1 ..

$ LIGHTING SCHEDULE FOR BARRACKS ROOMS
  LT-DS2   = D-SCH (1,6)(.1)(7,8)(1)(9,17)(.15)(18,24)(1) ..
  LT-WEHDS2= D-SCH (1,7)(.1)(8,24)(.2) ..
  LT-WS2   = W-SCH (WD) LT-DS2 (WEH) LT-WEHDS2 ..
  LT-SCH2  = SCHEDULE THRU DEC 31 LT-WS2 ..

$ LIGHTING SCHEDULE FOR FIRST FLOOR DAYROOM
  LT-DS1   = D-SCH (1,6)(.1)(7,8)(1)(9,17)(.25)(18,24)(1) ..
  LT-WEHDS1= D-SCH (1,7)(.1)(8,24)(.5) ..
  LT-WS1   = W-SCH (WD) LT-DS1 (WEH) LT-WEHDS1 ..
  LT-SCH1  = SCHEDULE THRU DEC 31 LT-WS1 ..

$ EQUIPMENT SCHEDULE FOR ALL AREAS
  EQ-DS     = D-SCH (1,7)(.1)(8,16)(.1)(17,24)(.8) ..
  EQ-WEHDS  = D-SCH (1,7)(.1)(8,16)(.2)(17,24)(.6) ..
  EQ-WS     = W-SCH (WD) EQ-DS (WEH) EQ-WEHDS ..
  EQ-SCH    = SCHEDULE THRU DEC 31 EQ-WS ..

$ ************************* SPACE CONDITIONS *********************

  BARRACK=S-C
  P-SCH=OC-SCH2  P-H-L=105  P-H-S=225  N-O-P=20  L-SCH=LT-SCH2
  L-T=REC-FLUOR-NV  L-W=0.5  L-T-S=1.0  E-SCH=EQ-SCH   E-KW=0.4
  INF-METHOD=AIR-CHANGE  AIR-CHANGES/HR=0.5 ..

  [illegible]RM=S-C
  P-SCH=OC-SCH1  P-H-L=105  P-H-S=225  N-O-P=4  L-SCH=LT-SCH1
  L-T=REC-FLUOR-NV  L-W=0.5  L-T-S=1.0  E-SCH=EQ-SCH   E-KW=.4
  INF-METHOD=AIR-CHANGE  AIR-CHANGES/HR=0.5 ..

  SET-DEFAULT FOR EXTERIOR-WALL CONS=WALL1 ..
```

```
   SET-DEFAULT FOR WINDOW  GLASS-TYPE=WINDOW1 ..
   SET-DEFAULT FOR INTERIOR-WALL CONS=FLOOR1  ..

$  *************************** SPACE INPUT *************************

$  FIRST FLOOR

   DAYROOM=S          X=0   Y=0   Z=0   AZ=0   A=2556  V=20448  S-C=DAYRM ..
   D-SWALL=E-W        X=0   Y=0   H=8   W=75    Z=0   AZ=180 ..
   D-SWIND1=WINDOW    X=5   Y=0   H=5   W=4 ..
   D-SWIND2=WINDOW    X=16  Y=0   H=5   W=4 ..
   D-SWIND3=WINDOW    X=29  Y=0   H=5   W=4 ..
   D-SWIND4=WINDOW    X=39  Y=0   H=5   W=4 ..
   D-SWIND5=WINDOW    X=53  Y=0   H=5   W=4 ..
   D-SWIND6=WINDOW    X=64  Y=0   H=5   W=4 ..

   1ROOM-S=S          X=95  Y=0   Z=0   AZ=0  A=2295  V=18360  S-C=BARRACK ..
   1RS-SWALL=E-W      X=0   Y=0   H=8   W=153  Z=0   AZ=180 ..
   1RS-SWW1=WINDOW    X=10  Y=0   H=5   W=4  M=12 ..
   1RS-EWALL=E-W      X=24  Y=0   H=8   W=24  Z=0  AZ=90 ..

   2ROOM-S=S          X=0   Y=0   Z=10  AZ=0  A=3735   V=29880  S-C=BARRACK ..
   2RS-SWALL=E-W      X=0   Y=0   H=8   W=249 Z=0  AZ=180 ..
   2RS-SWW1=WINDOW    X=5   Y=0   H=5   W=4    M=20   ..
   2RS-EWALL=E-W      X=24  Y=0   H=8   W=24  Z=0  AZ=90 ..
   1FLOOR=I-W         A=3735    TILT=0    N-T=1ROOM-S ..
   2FLOOR=I-W         A=3735    TILT=0    N-T=3ROOM-S ..

   3ROOM-S=S          X=0   Y=0   Z=20  AZ=0  A=3735  V=29880  S-C=BARRACK ..
   3RS-SWALL=E-W      X=0   Y=0   H=8   W=249 Z=0  AZ=180 ..
   3RS-SWW1=WINDOW    X=5   Y=0   H=5   W=4  M=20   ..
   3RS-EWALL=E-W      X=24  Y=0   H=8   W=24  Z=0  AZ=90 ..
   1ROOF=E-W          X=0   Y=0   Z=10  H=24  W=249  CONS=ROOF1  TILT=0   ..

   1ROOM-N=S          X=75  Y=22  Z=0   AZ=0  A=2220  V=17760  S-C=BARRACK ..
   1RN-NWALL=E-W      X=14  Y=15  H=8   W=150 Z=0  AZ=0 ..
   1RN-NWW1=WINDOW    X=5   Y=0   H=5   W=4    M=12   ..
   1RN-EWALL=E-W      X=24  Y=0   H=8   W=24  Z=0  AZ=90 ..

   2ROOM-N=S          X=0   Y=22  Z=10  AZ=0  A=3120  V=24960  S-C=BARRACK ..
   2RN-NWALL=E-W      X=25  Y=15  H=8   W=208 Z=0  AZ=0 ..
   2RN-NWW1=WINDOW    X=5   Y=0   H=5   W=4    M=18   ..
   2RN-EWALL=E-W      X=24  Y=0   H=8   W=24  Z=0  AZ=90 ..
   3FLOOR=I-W         A=3120    TILT=0    N-T=1ROOM-N ..
   4FLOOR=I-W         A=3120    TILT=0    N-T=3ROOM-N ..

   3ROOM-N=S          X=0   Y=22  Z=20  AZ=0  A=3120  V=24960  S-C=BARRACK ..
   3RN-NWALL=E-W      X=25  Y=15  H=8   W=208 Z=0  AZ=0 ..
   3RN-NWW1=WINDOW    X=5   Y=0   H=5   W=4    M=18   ..
   3RN-EWALL=E-W      X=24  Y=0   H=8   W=24  Z=0  AZ=90 ..
   2ROOF=E-W          X=0   Y=0   Z=10  H=24  W=208  CONS=ROOF1  TILT=0   ..

END ..
COMPUTE LOADS ..

$  *********************** SYSTEMS INPUT ****************************

INPUT SYSTEMS ..
SYSTEMS-REPORT V=(SV-A,SV-B) S=(SS-A,SS-B,SS-D,SS-F,SS-H,
                                SS-I,SS-J,SS-K,SS-L,SS-M) ..

$  HEATING AND COOLING DAY SCHEDULES

   H-1=D-SCH(1,24)(67) ..
   HW-1=W-SCH (ALL) H-1 ..
   H-2=D-SCH(1,24)(20) ..
```

```
  HW-2=W-SCH (ALL) H-2 ..
  HEAT1=SCHEDULE THRU MAR 31 HW-1
                 THRU SEP 30 HW-2
                 THRU DEC 31 HW-1 ..

  C-1=D-SCH(1,24)(72) ..
  CW-1=W-SCH (ALL) C-1 ..
  C-2=D-SCH(1,24)(100) ..
  CW-2=W-SCH (ALL) C-2 ..
  COOL1=SCHEDULE THRU MAR 31 CW-2
                 THRU SEP 30 CW-1
                 THRU DEC 31 CW-2 ..

$ MIN-AIR-SCH

  M-A-S-D=D-SCH(1,24)(.2)  ..
  M-A-S-W=W-SCH(ALL) M-A-S-D  ..
  M-A-S1=SCHEDULE THRU DEC 31 M-A-S-W  ..


$ HEATING AVAILABILITY

  H-A-SCH1=D-SCH(1,24) (1) ..
  H-A-SCH2=D-SCH(1,24) (0) ..
  H-A-WSCH1=W-SCH(ALL) H-A-SCH1 ..
  H-A-WSCH2=W-SCH(ALL) H-A-SCH2 ..
  HSCH1=SCHEDULE THRU MAR 31 H-A-WSCH1
                 THRU SEP 30 H-A-WSCH2
                 THRU DEC 31 H-A-WSCH1 ..

$ COOLING AVAILABILITY

 C-A-SCH1=D-SCH(1,24) (0) ..
 C-A-SCH2=D-SCH(1,24) (1) ..
 C-A-WSCH1=W-SCH(ALL) C-A-SCH1 ..
 C-A-WSCH2=W-SCH(ALL) C-A-SCH2 ..
 CSCH1=SCHEDULE THRU MAR 31 C-A-WSCH1
                THRU SEP 30 C-A-WSCH2
                THRU DEC 31 C-A-WSCH1 ..

$ FAN SCHEDULE
  F-1=D-SCH (1,24)(1) ..
  FW-1=W-SCH (ALL) F-1 ..
  FAN1=SCHEDULE THRU DEC 31 FW-1 ..

$ *************************** ZONE CONTROL ***************************

  ZNCTL=Z-C  D-H-T=67  H-T-SCH=HEAT1  D-C-T=72  C-T-SCH=COOL1 ..

$ *************************** ZONE INPUTS *****************************

  DAYROOM=Z     Z-C=ZNCTL    A-CFM=2800 ..
  1ROOM-S=Z     Z-C=ZNCTL    A-CFM=2200  ..
  1ROOM-N=Z     Z-C=ZNCTL    A-CFM=2200  ..
  2ROOM-S=Z     Z-C=ZNCTL    A-CFM=2200  ..
  2ROOM-N=Z     Z-C=ZNCTL    A-CFM=2200  ..
  3ROOM-S=Z     Z-C=ZNCTL    A-CFM=2200  ..
  3ROOM-N=Z     Z-C=ZNCTL    A-CFM=2200  ..

$ *************************** SYSTEM INPUT ***************************

  FANCOIL=SYSTEM
  S-TYPE=TPFC    S-CFM=9100    MIN-S-T=45  MAX-S-T=150  M-A-SCH=M-A-S1
                 F-SCH=FAN1    HEAT-SOURCE=HOT-WATER
                 H-SCH=HSCH1    C-SCH=CSCH1    Z-N= (DAYROOM,
                      1ROOM-S, 1ROOM-N, 2ROOM-S, 2ROOM-N, 3ROOM-S,
```

```
                     3ROOM-N) ..
END ..
COMPUTE SYSTEMS ..

$ ************************* PLANT PROGRAM *************************
$   .A INPUT TO SIMULATE A CENTRAL HOT WATER/CHILL WATER PLANT

INPUT PLANT ..
   DUMMY=PLANT-EQUIPMENT  TYPE=DIESEL-GEN  SIZE=0 ..

   ELEC=LOAD-ASSIGNMENT
   TYPE=ELECTRICAL    O-M=RUN-NEEDED  L-R=200.0  P-E=UTILITY N=1
                                      L-R=200.1  P-E=DUMMY   N=1 ..
   BUYCHILL=LOAD-ASSIGNMENT
   TYPE=COOLING       O-M=RUN-NEEDED  L-R=3.0    P-E=UTILITY N=1 ..

   BUYSTEAM=LOAD-ASSIGNMENT
   TYPE=HEATING       O-M=RUN-NEEDED  L-R=0.6    P-E=UTILITY N=1 ..

   LOAD-MANAGEMENT
   PRED-L-R=999       L-A=(BUYSTEAM,BUYCHILL,ELEC) ..

   ENERGY-COST        R=ELECTRICITY   U=3413     U-C=0.045 ..
   ENERGY-COST        R=CHILLED-WATER U=1000000  U-C=5.16 ..
   ENERGY-COST        R=STEAM         U=1000000  U-C=5.5 ..
   PLANT-REPORT       V=(PV-A) S=(PS-A,PS-D,BEPS) ..
END ..
COMPUTE PLANT ..
STOP ..
```

BASELINE MODEL OUTPUT

```
****    ***    *****        ***      *     ****
*  *   *   *   *           *   *     **    *
*  *   *   *   *****  ***     *      *     *
*  *   *   *   *             **      *     *
****    ***    *****        ***** *  ***   ****
```

BUILDING ENERGY ANALYSIS PROGRAM

DEVELOPED BY
LAWRENCE BERKELEY LABORATORY/UNIVERSITY OF CALIFORNIA

WITH MAJOR SUPPORT FROM
UNITED STATES DEPARTMENT OF ENERGY
ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE ENERGY
OFFICE OF BUILDINGS ENERGY RESEARCH AND DEVELOPMENT
BUILDING SYSTEMS DIVISION

LBL RELEASE AUG 1986

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M   M  IIIII  CCCC  RRRR    OOO       DDDD   OOO   EEEEE  222         222     1   CCCC
MM MM    I    C     R   R  O   O      D   D O   O  E     2   2       2   2   11   C
M M M    I    C     RRRR   O   O ===  D   D O   O  EEEEE    2   ===     2     1   C
M   M    I    C     R  R   O   O      D   D O   O  E      22          22      1   C
M   M  IIIII  CCCC  R   R   OOO       DDDD   OOO   EEEEE 22222       22222 * 111  CCCC
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ACROSOFT INTERNATIONAL,INC. / DENVER, COLORADO

FORT BRAGG HAMMERHEAD BARRACK BASELINE DOE-2.1C 10/19/1995 14:12:48 LDL RUN 1
GREEN
R[illegible] LV-A GENERAL PROJECT AND BUILDING INPUT WEATHER FILE- TMY NASHVILLE, TN

PERIOD OF STUDY

STARTING DATE	ENDING DATE	NUMBER OF DAYS
1 JAN 1991	31 DEC 1991	365

SITE CHARACTERISTIC DATA

STATION NAME	LATITUDE (DEG)	LONGITUDE (DEG)	ALTITUDE (FT)	TIME ZONE	BUILDING AZIMUTH (DEG)
TMY NASHVILLE, TN	36.1	86.4	941.	5 EST	0.0

FORT BRAGG HAMMERHEAD BARRACK BASELINE DOE-2.1C 10/19/1995 14:12:48 LDL RUN 1
GREEN
R LV-B SUMMARY OF SPACES OCCURRING IN THE PROJECT WEATHER FILE- TMY NASHVILLE, TN

NUMBER OF SPACES 7 EXTERIOR 7 INTERIOR 0

SPACE	SPACE MULT.	SPACE TYPE	AZIMUTH	LIGHTING (WATTS/ SQFT)	PEOPLE	EQUIP. (WATTS/ SQFT)	INFILTRATION METHOD	AIR CHANGES PER HOUR	FLOW RATE (CFM/SQFT)	AREA (SQFT)	VOLUME (CUFT)
DAYROOM	1.00	EXT	0.0	0.50	4.0	0.00	AIR-CHANGE	0.50	0.00	2556.	20448.
1ROOM-S	1.00	EXT	0.0	0.50	20.0	0.00	AIR-CHANGE	0.50	0.00	2295.	18360.
2ROOM-S	1.00	EXT	0.0	0.50	20.0	0.00	AIR-CHANGE	0.50	0.00	3735.	29880.
3ROOM-S	1.00	EXT	0.0	0.50	20.0	0.00	AIR-CHANGE	0.50	0.00	3735.	29880.
1ROOM-N	1.00	EXT	0.0	0.50	20.0	0.00	AIR-CHANGE	0.50	0.00	2220.	17760.
2ROOM-N	1.00	EXT	0.0	0.50	20.0	0.00	AIR-CHANGE	0.50	0.00	3120.	24960.
3ROOM-N	1.00	EXT	0.0	0.50	20.0	0.00	AIR-CHANGE	0.50	0.00	3120.	24960.
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BUILDING TOTALS					124.0					20781.00	166248.00

FORT BRAGG HAMMERHEAD BARRACK BASELINE DOE-2.1C 10/19/1995 14:12:48 LDL RUN 1
GREEN
R[illegible] LV-D DETAILS OF EXTERIOR SURFACES IN THE PROJECT WEATHER FILE- TMY NASHVILLE, TN

NUMBER OF EXTERIOR SURFACES 15 RECTANGULAR 15 OTHER 0

SURFACE	SPACE	----GLASS---- U-VALUE (BTU/HR - SQFT)	----GLASS---- AREA (SQFT)	----WALL---- U-VALUE (BTU/HR - SQFT)	----WALL---- AREA (SQFT)	-WALL+GLASS- U-VALUE (BTU/HR - SQFT)	-WALL+GLASS- AREA (SQFT)	AZIMUTH
1RN-NWALL	1ROOM-N	1.02	240.00	0.39	960.00	0.51	1200.00	NORTH
2RN-NWALL	2ROOM-N	1.02	360.00	0.39	1304.00	0.52	1664.00	NORTH
3RN-NWALL	3ROOM-N	1.02	360.00	0.39	1304.00	0.52	1664.00	NORTH
1RS-EWALL	1ROOM-S	0.00	0.00	0.39	192.00	0.39	192.00	EAST
1RN-EWALL	1ROOM-N	0.00	0.00	0.39	192.00	0.39	192.00	EAST
2RS-EWALL	2ROOM-S	0.00	0.00	0.39	192.00	0.39	192.00	EAST
2RN-EWALL	2ROOM-N	0.00	0.00	0.39	192.00	0.39	192.00	EAST
3[illegible]ALL	3ROOM-S	0.00	0.00	0.39	192.00	0.39	192.00	EAST
3RN-EWALL	3ROOM-N	0.00	0.00	0.39	192.00	0.39	192.00	EAST
3RS-SWALL	3ROOM-S	1.02	400.00	0.39	1592.00	0.51	1992.00	SOUTH
D-SWALL	DAYROOM	1.02	120.00	0.39	480.00	0.51	600.00	SOUTH
2RS-SWALL	2ROOM-S	1.02	400.00	0.39	1592.00	0.51	1992.00	SOUTH
1RS-SWALL	1ROOM-S	1.02	240.00	0.39	984.00	0.51	1224.00	SOUTH
1ROOF	3ROOM-S	0.00	0.00	0.25	5976.00	0.25	5976.00	ROOF
2ROOF	3ROOM-N	0.00	0.00	0.25	4992.00	0.25	4992.00	ROOF

FORT BRAGG HAMMERHEAD BARRACK BASELINE DOE-2.1C 10/19/1995 14:12:48 LDL RUN 1
GREEN
R[illegible] LV-D DETAILS OF EXTERIOR SURFACES IN THE PROJECT WEATHER FILE- TMY NASHVILLE, TN
---(CONTINUED)--------

	AVERAGE U-VALUE/GLASS (BTU/HR - SQFT)	AVERAGE U-VALUE/WALLS (BTU/HR - SQFT)	AVERAGE U-VALUE WALLS+GLASS (BTU/HR - SQFT)	GLASS AREA (SQFT)	OPAQUE AREA (SQFT)	GLASS+OPAQUE AREA (SQFT)
NORTH	1.02	0.39	0.52	960.00	3568.00	4528.00
EAST	0.00	0.39	0.39	0.00	1152.00	1152.00
SOUTH	1.02	0.39	0.51	1160.00	4648.00	5808.00
ROOF	0.00	0.25	0.25	0.00	10968.00	10968.00
ALL WALLS	1.02	0.39	0.50	2120.00	9368.00	11488.00
WALLS+ROOFS	1.02	0.31	0.38	2120.00	20336.00	22456.00
BUILDING	1.02	0.31	0.38	2120.00	20336.00	22456.00

FORT BRAGG HAMMERHEAD BARRACK BASELINE DOE-2.1C 10/19/1995 14:12:48 LDL RUN 1
GREEN
REPORT- LV-I DETAILS OF CONSTRUCTIONS OCCURRING IN THE PROJECT WEATHER FILE- TMY NASHVILLE, TN

NUMBER OF CONSTRUCTIONS 3 DELAYED 2 QUICK 1

CONSTRUCTION NAME	U-VALUE (BTU/HR - SQFT)	SURFACE ABSORPTANCE	SURFACE ROUGHNESS INDEX	SURFACE TYPE	NUMBER OF RESPONSE FACTORS
WALL1	0.42	0.65	2	DELAYED	13
ROOF1	0.26	0.35	1	DELAYED	5
FLOOR1	0.50	0.70	3	QUICK	0

FORT BRAGG HAMMERHEAD BARRACK BASELINE DOE-2.1C 10/19/1995 14:12:48 LDL RUN 1
GREEN
REPORT- LS-A SPACE PEAK LOADS SUMMARY WEATHER FILE- TMY NASHVILLE, TN

SPACE NAME	MULTIPLIER SPACE	MULTIPLIER FLOOR	COOLING LOAD (KBTU/HR)	TIME OF PEAK	DRY-BULB	WET-BULB	HEATING LOAD (KBTU/HR)	TIME OF PEAK	DRY-BULB	WET-BULB
DAYROOM	1.	1.	18.625	OCT 12 4 PM	87.F	71.F	-29.854	JAN 12 8 AM	14.F	12.F
1ROOM-S	1.	1.	35.691	SEP 5 6 PM	89.F	75.F	-45.661	JAN 12 8 AM	14.F	12.F
2ROOM-S	1.	1.	54.580	SEP 5 6 PM	89.F	75.F	-73.960	JAN 12 8 AM	14.F	12.F
3ROOM-S	1.	1.	87.807	SEP 5 6 PM	89.F	75.F	-154.453	JAN 12 8 AM	14.F	12.F
1ROOM-N	1.	1.	29.330	JUL 9 6 PM	89.F	76.F	-47.252	JAN 12 8 AM	14.F	12.F
2ROOM-N	1.	1.	39.201	JUL 9 6 PM	89.F	76.F	-66.487	JAN 12 8 AM	14.F	12.F
3ROOM-N	1.	1.	70.215	JUN 30 6 PM	92.F	74.F	-133.727	JAN 12 8 AM	14.F	12.F
SUM			335.449				-551.395			
BUILDING PEAK			319.670	JUL 9 6 PM	89.F	76.F	-551.395	JAN 12 8 AM	14.F	12.F

FORT BRAGG HAMMERHEAD BARRACK BASELINE DOE-2.1C 10/19/1995 14:12:48 LDL RUN 1
GREEN
REPORT- LS-C BUILDING PEAK LOAD COMPONENTS WEATHER FILE- TMY NASHVILLE, TN

*** BUILDING ***

FLOOR AREA	20781	SQFT	1931	SQMT
VOLUME	166248	CUFT	4708	CUMT

	COOLING LOAD				HEATING LOAD	
TIME	JUL 9 6PM				JAN 12 8AM	
DRY-BULB TEMP	89F	32C			14F	-10C
WET-BULB TEMP	76F	24C			12F	-11C

	SENSIBLE (KBTU/H)	SENSIBLE (KW)	LATENT (KBTU/H)	LATENT (KW)	SENSIBLE (KBTU/H)	SENSIBLE (KW)
WALLS	74.407	21.792	0.000	0.000	-167.439	-49.039
ROOFS	65.880	19.294	0.000	0.000	-147.733	-43.267
GLASS CONDUCTION	41.822	12.249	0.000	0.000	-128.860	-37.740
GLASS SOLAR	54.658	16.008	0.000	0.000	11.746	3.440
DOOR	0.000	0.000	0.000	0.000	0.000	0.000
INTERNAL SURFACES	0.000	0.000	0.000	0.000	0.000	0.000
UNDERGROUND SURFACES	0.000	0.000	0.000	0.000	0.000	0.000
OCCUPANTS TO SPACE	21.846	6.398	12.642	3.703	12.798	3.748
LIGHT TO SPACE	23.191	6.792	0.000	0.000	10.036	2.939
EQUIPMENT TO SPACE	5.927	1.736	0.000	0.000	2.167	0.635
PROCESS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
INFILTRATION	31.940	9.354	58.339	17.086	-144.109	-42.206
TOTAL	319.670	93.623	70.981	20.788	-551.395	-161.490

TOTAL LOAD	390.650 KBTU/H	114.412 KW	-551.395 KBTU/H	-161.490 KW
TOTAL LOAD / AREA	18.80BTU/H.SQFT	59.262 W /SQMT	26.534BTU/H.SQFT	83.647 W /SQMT

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*                                                              *
*  NOTE   1)THE ABOVE LOADS EXCLUDE OUTSIDE VENTILATION AIR    *
*  ----     LOADS                                              *
*         2)TIMES GIVEN IN STANDARD TIME FOR THE LOCATION      *
*           IN CONSIDERATION                                   *
*                                                              *
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FORT BRAGG HAMMERHEAD BARRACK BASELINE DOE-2.1C 10/19/1995 14:12:48 LDL RUN 1
GREEN
REPORT- LS-D BUILDING MONTHLY LOADS SUMMARY WEATHER FILE- TMY NASHVILLE, TN

MONTH	COOLING ENERGY (MBTU)	COOLING TIME OF MAX DY	COOLING TIME OF MAX HR	COOLING DRY-BULB TEMP	COOLING WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	HEATING TIME OF MAX DY	HEATING TIME OF MAX HR	HEATING DRY-BULB TEMP	HEATING WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC- TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	0.66286	31	15	51.F	38.F	32.945	-165.981	12	8	14.F	12.F	-551.395	3646.	12.625
FEB	1.73368	10	14	68.F	51.F	62.324	-127.595	19	9	20.F	17.F	-456.031	3234.	12.625
MAR	4.31264	24	16	72.F	60.F	80.468	-98.553	30	4	23.F	20.F	-425.416	3578.	12.625
APR	23.98875	29	17	80.F	62.F	213.386	-42.077	9	6	33.F	32.F	-280.362	3576.	12.625
MAY	58.45398	9	17	85.F	68.F	276.842	-10.327	1	9	47.F	37.F	-182.291	3646.	12.625
JUN	103.59642	30	17	92.F	74.F	312.875	-0.429	14	5	55.F	53.F	-30.607	3441.	12.625
JUL	129.37885	9	17	89.F	76.F	319.670	-0.044	13	6	61.F	61.F	-11.948	3646.	12.625
AUG	117.47043	27	17	88.F	73.F	317.133	-0.093	23	8	67.F	61.F	-14.913	3646.	12.625
SEP	82.16725	5	17	89.F	75.F	312.280	-2.207	28	7	53.F	50.F	-73.330	3441.	12.625
OCT	33.05577	12	15	87.F	71.F	245.527	-35.323	28	8	43.F	38.F	-229.400	3646.	12.625
NOV	5.57543	18	18	66.F	58.F	83.578	-89.090	2	21	32.F	30.F	-388.359	3373.	12.625
DEC	0.90391	21	15	66.F	54.F	35.336	-165.211	24	3	23.F	20.F	-449.155	3578.	12.625
TOTAL	561.300						-736.929						42449.	
MAX						319.670						-551.395		12.625

FORT BRAGG HAMMERHEAD BARRACK BASELINE DOE-2.1C 10/19/1995 14:12:48 SDL RUN 1
GREEN
REPORT- SV-A SYSTEM DESIGN PARAMETERS FANCOIL WEATHER FILE- TMY NASHVILLE, TN

SYSTEM NAME	ALTITUDE MULTIPLIER
FANCOIL	1.030

SUPPLY FAN (CFM)	ELEC (KW)	DELTA-T (F)	RETURN FAN (CFM)	ELEC (KW)	DELTA-T (F)	OUTSIDE AIR RATIO	COOLING CAPACITY (KBTU/HR)	SENSIBLE (SHR)	HEATING CAPACITY (KBTU/HR)	COOLING EIR (BTU/BTU)	HEATING EIR (BTU/BTU)
16480.	0.000	0.2	0.	0.000	0.0	0.000	0.000	0.000	0.000	0.00	0.00

ZONE NAME	SUPPLY FLOW	EXHAUST FLOW	FAN (KW)	MINIMUM FLOW RATIO	OUTSIDE AIR FLOW	COOLING CAPACITY (KBTU/HR)	SENSIBLE (SHR)	EXTRACTION RATE (KBTU/HR)	HEATING CAPACITY (KBTU/HR)	ADDITION RATE (KBTU/HR)	MULTIPLIER
DAYROOM	2884.	0.	0.196	1.000	0.	153.20	0.66	80.93	-250.12	-250.75	1.0
1ROOM-S	2266.	0.	0.154	1.000	0.	114.96	0.69	63.58	-196.52	-197.02	1.0
1ROOM-N	2266.	0.	0.154	1.000	0.	121.04	0.65	63.58	-196.52	-197.02	1.0
2ROOM-S	2266.	0.	0.154	1.000	0.	119.09	0.66	63.58	-196.52	-197.02	1.0
2ROOM-N	2266.	0.	0.154	1.000	0.	125.78	0.63	63.59	-196.52	-197.02	1.0
3ROOM-S	2266.	0.	0.154	1.000	0.	119.09	0.66	63.58	-196.52	-197.02	1.0
3ROOM-N	2266.	0.	0.154	1.000	0.	120.84	0.65	63.58	-196.52	-197.02	1.0

FORT BRAGG HAMMERHEAD BARRACK BASELINE DOE-2.1C 10/19/1995 14:12:48 SDL RUN 1
GREEN
REPORT- SS-D PLANT MONTHLY LOADS SUMMARY FOR DEFAULT-PLANT WEATHER FILE- TMY NASHVILLE, TN

	- - - COOLING - - -						- - - HEATING - - -						- - - ELEC - - -	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	0.00000					0.000	-218.947	12	8	14.F	12.F	-699.641	4479.	13.745
FEB	0.00000					0.000	-171.254	19	7	18.F	16.F	-591.323	3986.	13.745
MAR	0.00000					0.000	-127.952	30	6	22.F	19.F	-545.045	4411.	13.745
APR	13.89355	28	16	83.F	64.F	212.660	0.000					0.000	4383.	13.745
MAY	53.18752	16	18	86.F	71.F	327.268	0.000					0.000	4479.	13.745
JUN	119.61391	30	16	95.F	75.F	420.844	0.000					0.000	4247.	13.745
JUL	177.34996	23	18	91.F	77.F	456.990	0.000					0.000	4479.	13.745
AUG	151.03398	20	17	90.F	78.F	454.517	0.000					0.000	4479.	13.745
SEP	89.11276	5	18	89.F	75.F	421.663	0.000					0.000	4247.	13.745
OCT	0.00000					0.000	-54.943	28	6	35.F	32.F	-296.220	4479.	13.745
NOV	0.00000					0.000	-115.360	4	6	24.F	22.F	-488.107	4179.	13.745
DEC	0.00000					0.000	-217.048	25	6	8.F	7.F	-612.240	4411.	13.745
TOTAL	604.192						-905.503						52262.	
MAX						456.990						-699.641		13.745

FORT BRAGG HAMMERHEAD BARRACK BASELINE DOE-2.1C 10/19/1995 14:12:48 SDL RUN 1
GREEN
REPORT- SS-M FAN ELECTRIC ENERGY FOR PLANT DEFAULT-PLANT WEATHER FILE- TMY NASHVILLE, TN

MONTH	FAN ELECTRIC ENERGY DURING HEATING (KWH)	FAN ELECTRIC ENERGY DURING COOLING (KWH)	FAN ELECTRIC ENERGY DURING HEATING-COOLING (KWH)	FAN ELECTRIC ENERGY DURING FLOATING (KWH)
JAN	833.277	0.000	0.000	0.000
FEB	747.037	0.000	0.000	5.600
MAR	820.957	0.000	0.000	12.320
APR	0.000	358.399	0.000	447.999
MAY	0.000	607.038	0.000	226.240
JUN	0.000	789.597	0.000	16.800
JUL	0.000	832.157	0.000	1.120
AUG	0.000	833.277	0.000	0.000
SEP	0.000	742.557	0.000	63.840
OCT	815.357	0.000	0.000	17.920
NOV	806.397	0.000	0.000	0.000
DEC	833.277	0.000	0.000	0.000
ANNUAL	4856.605	4163.253	0.000	791.837

FORT BRAGG HAMMERHEAD BARRACK BASELINE DOE-2.1C 10/19/1995 14:12:48 SDL RUN 1
GREEN
REPORT- SS-A SYSTEM MONTHLY LOADS SUMMARY FOR FANCOIL WEATHER FILE- TMY NASHVILLE, TN

	- - - - - - - - C O O L I N G - - - - - - - -						- - - - - - - - H E A T I N G - - - - - - - -						- - - E L E C - - -	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	0.00000					0.000	-218.947	12	8	14.F	12.F	-699.641	4479.	13.745
FEB	0.00000					0.000	-171.254	19	7	18.F	16.F	-591.323	3986.	13.745
MAR	0.00000					0.000	-127.952	30	6	22.F	19.F	-545.045	4411.	13.745
APR	13.89355	28	16	83.F	64.F	212.660	0.000					0.000	4383.	13.745
MAY	53.18752	16	18	86.F	71.F	327.268	0.000					0.000	4479.	13.745
JUN	119.61391	30	16	95.F	75.F	420.844	0.000					0.000	4247.	13.745
JUL	177.34996	23	18	91.F	77.F	456.990	0.000					0.000	4479.	13.745
AUG	151.03398	20	17	90.F	78.F	454.517	0.000					0.000	4479.	13.745
SEP	89.11276	5	18	89.F	75.F	421.663	0.000					0.000	4247.	13.745
OCT	0.00000					0.000	-54.943	28	6	35.F	32.F	-296.220	4479.	13.745
NOV	0.00000					0.000	-115.360	4	6	24.F	22.F	-488.107	4179.	13.745
DEC	0.00000					0.000	-217.048	25	6	8.F	7.F	-612.240	4411.	13.745
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TOTAL	604.192						-905.503						52262.	
MAX						456.990						-699.641		13.745

FORT BRAGG HAMMERHEAD BARRACK BASELINE DOE-2.1C 10/19/1995 14:12:48 SDL RUN 1
GREEN
REPORT- SS-B SYSTEM MONTHLY LOADS SUMMARY FOR FANCOIL WEATHER FILE- TMY NASHVILLE, TN

	--ZONE COOLING--		--ZONE HEATING-		--BASEBOARDS--		----PRE-HEAT---	
MONTH	ZONE COIL COOLING ENERGY (MBTU)	MAXIMUM ZONE COIL COOLING LOAD (KBTU/HR)	ZONE COIL HEATING ENERGY (MBTU)	MAXIMUM ZONE COIL HEATING LOAD (KBTU/HR)	BASEBOARD HEATING ENERGY (MBTU)	MAXIMUM BASEBOARD HEATING LOAD (KBTU/HR)	PRE-HEAT COIL ENERGY (MBTU)	MAXIMUM PRE-HEAT COIL LOAD (KBTU/HR)
JAN	0.00000	0.000	-218.94743	-699.641	0.00000	0.000	0.00000	0.000
FEB	0.00000	0.000	-171.25418	-591.323	0.00000	0.000	0.00000	0.000
MAR	0.00000	0.000	-127.95153	-545.045	0.00000	0.000	0.00000	0.000
APR	13.89355	212.660	0.00000	0.000	0.00000	0.000	0.00000	0.000
MAY	53.18752	327.268	0.00000	0.000	0.00000	0.000	0.00000	0.000
JUN	119.61391	420.844	0.00000	0.000	0.00000	0.000	0.00000	0.000
JUL	177.34996	456.990	0.00000	0.000	0.00000	0.000	0.00000	0.000
AUG	151.03398	454.517	0.00000	0.000	0.00000	0.000	0.00000	0.000
SEP	89.11276	421.663	0.00000	0.000	0.00000	0.000	0.00000	0.000
OCT	0.00000	0.000	-54.94255	-296.220	0.00000	0.000	0.00000	0.000
NOV	0.00000	0.000	-115.36021	-488.107	0.00000	0.000	0.00000	0.000
DEC	0.00000	0.000	-217.04816	-612.240	0.00000	0.000	0.00000	0.000
TOTAL	604.192		-905.503		0.000		0.000	
MAX		456.990		-699.641		0.000		0.000

FORT BRAGG HAMMERHEAD BARRACK BASELINE DOE-2.1C 10/19/1995 14:12:48 SDL RUN 1
GREEN
REPORT- SS-H SYSTEM MONTHLY LOADS SUMMARY FOR FANCOIL WEATHER FILE- TMY NASHVILLE, TN

	- - - -F A N E L E C- - - -		- - -F U E L H E A T - - - -		- - E L E C H E A T - - -		- - -E L E C C O O L - - -	
MONTH	FAN ELECTRIC ENERGY (KWH)	MAXIMUM FAN ELECTRIC LOAD (KW)	GAS OIL HEATING ENERGY (MBTU)	MAXIMUM GAS OIL HEATING LOAD (KBTU/HR)	ELECTRIC HEATING ENERGY (KWH)	MAXIMUM ELECTRIC HEATING LOAD (KW)	ELECTRIC COOLING ENERGY (KWH)	MAXIMUM ELECTRIC COOLING LOAD (KW)
JAN	833.	1.120	0.00000	0.000	0.	0.000	0.	0.000
FEB	753.	1.120	0.00000	0.000	0.	0.000	0.	0.000
MAR	833.	1.120	0.00000	0.000	0.	0.000	0.	0.000
APR	806.	1.120	0.00000	0.000	0.	0.000	0.	0.000
MAY	833.	1.120	0.00000	0.000	0.	0.000	0.	0.000
JUN	806.	1.120	0.00000	0.000	0.	0.000	0.	0.000
JUL	833.	1.120	0.00000	0.000	0.	0.000	0.	0.000
AUG	833.	1.120	0.00000	0.000	0.	0.000	0.	0.000
SEP	806.	1.120	0.00000	0.000	0.	0.000	0.	0.000
OCT	833.	1.120	0.00000	0.000	0.	0.000	0.	0.000
NOV	806.	1.120	0.00000	0.000	0.	0.000	0.	0.000
DEC	833.	1.120	0.00000	0.000	0.	0.000	0.	0.000
TOTAL	9812.		0.000		0.		0.	
MAX		1.120		0.000		0.000		0.000

FORT BRAGG HAMMERHEAD BARRACK BASELINE DOE-2.1C 10/19/1995 14:12:48 SDL RUN 1
GREEN
REF SS-I SYSTEM MONTHLY SOURCE-LATENT SUMMARY FOR FANCOIL WEATHER FILE- TMY NASHVILLE, TN

MONTH	SENSIBLE COOLING ENERGY (MBTU)	LATENT COOLING ENERGY (MBTU)	MAX TOTAL COOLING ENERGY (KBTU/HR)	SENSIBLE HEAT RATIO AT MAX	TIME OF MAX DY	HR	SENSIBLE HEATING ENERGY (MBTU)	LATENT HEATING ENERGY (MBTU)	MAX TOTAL HEATING ENERGY (KBTU/HR)
JAN	0.00000	0.00000	0.000				-218.94743	0.00000	-699.64075
FEB	0.00000	0.00000	0.000				-171.25418	0.00000	-591.32288
MAR	0.00000	0.00000	0.000				-127.95153	0.00000	-545.04541
APR	13.63613	0.25742	212.660	0.841	28	16	0.00000	0.00000	0.000
MAY	49.75434	3.43318	327.268	0.837	16	18	0.00000	0.00000	0.000
JUN	103.92254	15.69137	420.844	0.806	30	16	0.00000	0.00000	0.000
JUL	136.40178	40.94820	456.990	0.704	23	18	0.00000	0.00000	0.000
AUG	121.79212	29.24186	454.517	0.715	20	17	0.00000	0.00000	0.000
SEP	77.13023	11.98254	421.663	0.763	5	18	0.00000	0.00000	0.000
OCT	0.00000	0.00000	0.000				-54.94255	0.00000	-296.22003
NOV	0.00000	0.00000	0.000				-115.36021	0.00000	-488.10748
DEC	0.00000	0.00000	0.000				-217.04816	0.00000	-612.24030
TOTAL	502.638	101.554					-905.503	0.000	
MAX			456.990	0.704					-699.641

FORT BRAGG HAMMERHEAD BARRACK BASELINE DOE-2.1C 10/19/1995 14:12:48 SDL RUN 1
GREEN
REF SS-J SYSTEM PEAK HEATING AND COOLING DAYS FOR FANCOIL WEATHER FILE- TMY NASHVILLE, TN

	- - - - - C O O L I N G - - - - -				- - - H E A T I N G - - -		
	JUL 23				JAN 12		
HOUR	HOURLY COOLING LOAD (KBTU)	SENSIBLE HEAT RATIO	DRY-BULB TEMP	WET-BULB TEMP	HOURLY HEATING LOAD (KBTU)	DRY-BULB TEMP	WET-BULB TEMP
1	221.334	0.728	70.F	70.F	-546.779	20.F	18.F
2	190.707	0.769	70.F	69.F	-540.232	19.F	17.F
3	161.968	0.798	69.F	68.F	-617.243	18.F	16.F
4	154.535	0.762	69.F	69.F	-629.395	16.F	14.F
5	142.912	0.780	70.F	69.F	-602.374	15.F	13.F
6	149.577	0.779	70.F	69.F	-657.856	15.F	13.F
7	181.569	0.725	75.F	72.F	-630.154	14.F	12.F
8	208.305	0.700	79.F	74.F	-699.641	14.F	12.F
9	258.231	0.694	84.F	76.F	-667.206	15.F	13.F
10	282.163	0.721	86.F	76.F	-629.215	17.F	14.F
11	324.732	0.711	88.F	77.F	-579.405	18.F	15.F
[illegible]	357.855	0.733	90.F	77.F	-555.736	19.F	16.F
[illegible]	385.198	0.744	91.F	77.F	-543.217	21.F	18.F
14	404.598	0.745	91.F	77.F	-523.763	21.F	17.F
15	421.008	0.754	92.F	77.F	-521.405	21.F	17.F
16	440.297	0.747	91.F	77.F	-546.115	19.F	16.F
17	456.990	0.748	91.F	77.F	-566.104	16.F	13.F
18	456.989	0.740	90.F	77.F	-573.164	16.F	13.F
19	444.548	0.718	87.F	77.F	-558.011	14.F	12.F
20	434.167	0.703	85.F	77.F	-587.665	14.F	12.F
21	404.633	0.698	82.F	76.F	-591.000	12.F	10.F
22	377.199	0.701	80.F	75.F	-600.794	12.F	10.F
23	364.667	0.691	79.F	75.F	-577.138	12.F	10.F
24	312.894	0.691	77.F	74.F	-590.107	11.F	9.F
	--------				--------		
MAX	456.990				-699.641		

FORT BRAGG HAMMERHEAD BARRACK BASELINE DOE-2.1C 10/19/1995 14:12:48 SDL RUN 1
GREEN
RE[illegible] SS-K SPACE TEMPERATURE SUMMARY FANCOIL WEATHER FILE- TMY NASHVILLE, TN

	A V E R A G E S P A C E T E M P					AVERAGE TEMPERATURE DIFFERENCE			SUMMED TEMP DIFFERENCE		
						BETWEEN OUTDOOR& ROOM AIR	BETWEEN OUTDOOR& ROOM AIR	BETWEEN OUTDOOR& ROOM AIR	BETWEEN OUTDOOR& ROOM AIR	BETWEEN OUTDOOR& ROOM AIR	HUMIDITY RATIO DIFFERENCE BETWEEN
MONTH	ALL HOURS (F)	COOLING HOURS (F)	HEATING HOURS (F)	FAN ON HOURS (F)	FAN OFF HOURS (F)	ALL HOURS (F)	FAN ON HOURS (F)	FAN OFF HOURS (F)	HEATING HOURS (F)	ALL HOURS (F)	OUTDOOR AND ROOM AIR (PERCENT-RH)
JAN	67.77		67.77	67.77	0.00	-27.63	-27.63	0.00	856.49	856.49	-0.00001
FEB	67.98		67.98	67.98	0.00	-25.77	-25.77	0.00	722.28	722.57	-0.00001
MAR	68.32		68.30	68.32	0.00	-19.05	-19.05	0.00	592.19	592.99	-0.00001
APR	66.35	68.81		66.35	0.00	-7.87	-7.87	0.00		296.36	0.00002
MAY	70.56	71.24		70.56	0.00	-2.97	-2.97	0.00		240.66	0.00034
JUN	71.70	71.72		71.70	0.00	3.43	3.43	0.00		212.58	0.00162
JUL	71.88	71.88		71.88	0.00	6.38	6.38	0.00		233.12	0.00395
AUG	71.80	71.80		71.80	0.00	5.09	5.09	0.00		214.41	0.00285
SEP	71.47	71.57		71.47	0.00	-0.08	-0.08	0.00		212.85	0.00123
OCT	73.50		73.49	73.50	0.00	-13.20	-13.20	0.00	417.38	420.83	-0.00001
NOV	68.72		68.72	68.72	0.00	-18.02	-18.02	0.00	541.77	541.77	-0.00001
DEC	67.82		67.82	67.82	0.00	-27.30	-27.30	0.00	846.40	846.40	-0.00001
ANNUAL	69.84	71.42	69.02	69.84	0.00	-10.51	-10.51	0.00	3976.50	5391.04	0.00084

FORT BRAGG HAMMERHEAD BARRACK BASELINE DOE-2.1C 10/19/1995 14:12:48 SDL RUN 1
GREEN
R[illegible] SS-L FAN ELECTRIC ENERGY FANCOIL WEATHER FILE- TMY NASHVILLE, TN

MONTH	FAN ELECTRIC ENERGY DURING HEATING (KWH)	FAN ELECTRIC ENERGY DURING COOLING (KWH)	FAN ELECTRIC ENERGY DURING HEATING-COOLING (KWH)	FAN ELECTRIC ENERGY DURING FLOATING (KWH)
JAN	833.277	0.000	0.000	0.000
FEB	747.037	0.000	0.000	5.600
MAR	820.957	0.000	0.000	12.320
APR	0.000	358.399	0.000	447.999
MAY	0.000	607.038	0.000	226.240
JUN	0.000	789.597	0.000	16.800
JUL	0.000	832.157	0.000	1.120
AUG	0.000	833.277	0.000	0.000
[illegible]	0.000	742.557	0.000	63.840
OCT	815.357	0.000	0.000	17.920
NOV	806.397	0.000	0.000	0.000
DEC	833.277	0.000	0.000	0.000
ANNUAL	4856.605	4163.253	0.000	791.837

FORT BRAGG HAMMERHEAD BARRACK BASELINE DOE-2.1C 10/19/1995 14:12:48 SDL RUN 1
GREEN
REPORT- SS-F ZONE DEMAND SUMMARY IN FANCOIL FOR DAYROOM WEATHER FILE- TMY NASHVILLE, TN

	- - - - D E M A N D S - - - - -		- - B A S E B O A R D S - - -		- - T E M P E R A T U R E S - -		- - L O A D S N O T M E T - -	
MONTH	HEAT EXTRACTION ENERGY (MBTU)	HEAT ADDITION ENERGY (MBTU)	BASEBOARD ENERGY (MBTU)	MAXIMUM BASEBOARD LOAD (KBTU/HR)	MAXIMUM ZONE TEMP (F)	MINIMUM ZONE TEMP (F)	HOURS UNDER HEATED	HOURS UNDER COOLED
JAN	0.00096	-5.551	0.00000	0.000	70.0	67.8	0	0
FEB	0.00188	-3.830	0.00000	0.000	72.9	67.9	0	0
MAR	0.00174	-2.647	0.00000	0.000	72.3	67.9	0	0
APR	1.16511	-0.319	0.00000	0.000	71.4	60.9	0	0
MAY	3.23034	-0.103	0.00000	0.000	71.5	68.5	0	0
JUN	5.33680	-0.003	0.00000	0.000	71.6	70.9	0	0
JUL	6.59021	0.000	0.00000	0.000	71.6	71.0	0	0
AUG	6.44213	0.000	0.00000	0.000	71.6	71.1	0	0
SEP	5.12192	-0.006	0.00000	0.000	71.6	70.5	0	0
OCT	0.00403	-0.501	0.00000	0.000	89.2	68.2	0	0
NOV	0.00343	-2.196	0.00000	0.000	73.9	67.9	0	0
DEC	0.00055	-5.518	0.00000	0.000	70.4	67.9	0	0

FORT BRAGG HAMMERHEAD BARRACK BASELINE DOE-2.1C 10/19/1995 14:12:48 SDL RUN 1
GREEN
RE SS-F ZONE DEMAND SUMMARY IN FANCOIL FOR 1ROOM-S WEATHER FILE- TMY NASHVILLE, TN

	----DEMANDS-----		---BASEBOARDS---		--TEMPERATURES--		--LOADS NOT MET--	
MONTH	HEAT EXTRACTION ENERGY (MBTU)	HEAT ADDITION ENERGY (MBTU)	BASEBOARD ENERGY (MBTU)	MAXIMUM BASEBOARD LOAD (KBTU/HR)	MAXIMUM ZONE TEMP (F)	MINIMUM ZONE TEMP (F)	HOURS UNDER HEATED	HOURS UNDER COOLED
JAN	0.00197	-9.491	0.00000	0.000	70.8	67.6	0	0
FEB	0.00462	-6.575	0.00000	0.000	73.5	67.7	0	0
MAR	0.00841	-4.203	0.00000	0.000	73.6	67.7	0	0
APR	2.33414	-0.258	0.00000	0.000	71.8	57.1	0	0
MAY	6.23679	-0.098	0.00000	0.000	72.0	66.1	0	0
JUN	10.57571	0.000	0.00000	0.000	72.1	71.1	0	0
JUL	13.03589	0.000	0.00000	0.000	72.1	71.1	0	0
AUG	12.87281	0.000	0.00000	0.000	72.2	71.2	0	0
SEP	10.28748	-0.004	0.00000	0.000	72.3	70.7	0	0
OCT	0.03262	-0.559	0.00000	0.000	89.2	67.9	0	0
NOV	0.01545	-3.699	0.00000	0.000	74.9	67.7	0	0
DEC	0.00314	-9.458	0.00000	0.000	71.2	67.7	0	0

FORT BRAGG HAMMERHEAD BARRACK BASELINE DOE-2.1C 10/19/1995 14:12:48 SDL RUN 1
GREEN
REPORT- SS-F ZONE DEMAND SUMMARY IN FANCOIL FOR 1ROOM-N WEATHER FILE- TMY NASHVILLE, TN

	- - - - DEMANDS - - - - -		- - BASEBOARDS - - -		- - TEMPERATURES - -		- - LOADS NOT MET - -	
MONTH	HEAT EXTRACTION ENERGY (MBTU)	HEAT ADDITION ENERGY (MBTU)	BASEBOARD ENERGY (MBTU)	MAXIMUM BASEBOARD LOAD (KBTU/HR)	MAXIMUM ZONE TEMP (F)	MINIMUM ZONE TEMP (F)	HOURS UNDER HEATED	HOURS UNDER COOLED
JAN	0.00000	-12.335	0.00000	0.000	68.0	67.6	0	0
FEB	0.00000	-9.264	0.00000	0.000	70.2	67.7	0	0
MAR	0.00011	-6.448	0.00000	0.000	71.9	67.7	0	0
APR	1.13201	-0.285	0.00000	0.000	71.6	54.9	0	0
MAY	5.01658	-0.109	0.00000	0.000	71.9	64.8	0	0
JUN	9.82404	0.000	0.00000	0.000	72.0	71.1	0	0
JUL	11.90276	0.000	0.00000	0.000	72.1	71.2	0	0
AUG	10.37389	0.000	0.00000	0.000	72.0	71.2	0	0
SEP	6.48120	-0.022	0.00000	0.000	71.9	69.9	0	0
OCT	0.00174	-1.783	0.00000	0.000	82.4	67.9	0	0
NOV	0.00005	-5.996	0.00000	0.000	71.5	67.7	0	0
DEC	0.00000	-12.351	0.00000	0.000	69.5	67.7	0	0

FORT BRAGG HAMMERHEAD BARRACK BASELINE DOE-2.1C 10/19/1995 14:12:48 SDL RUN 1
GREEN
REPORT- SS-F ZONE DEMAND SUMMARY IN FANCOIL FOR 2ROOM-S WEATHER FILE- TMY NASHVILLE, TN

	- - - -DEMANDS- - - - -		- -BASEBOARDS- - -		- -TEMPERATURES- -		- -LOADS NOT MET- -	
MONTH	HEAT EXTRACTION ENERGY (MBTU)	HEAT ADDITION ENERGY (MBTU)	BASEBOARD ENERGY (MBTU)	MAXIMUM BASEBOARD LOAD (KBTU/HR)	MAXIMUM ZONE TEMP (F)	MINIMUM ZONE TEMP (F)	HOURS UNDER HEATED	HOURS UNDER COOLED
JAN	0.00163	-16.152	0.00000	0.000	70.3	67.3	0	0
FEB	0.00353	-11.331	0.00000	0.000	72.6	67.5	0	0
MAR	0.00679	-7.475	0.00000	0.000	73.0	67.5	0	0
APR	2.85978	-0.278	0.00000	0.000	72.0	55.9	0	0
MAY	8.25663	-0.117	0.00000	0.000	72.3	64.7	0	0
JUN	14.78680	0.000	0.00000	0.000	72.5	71.0	0	0
JUL	18.59884	0.000	0.00000	0.000	72.5	71.1	0	0
AUG	18.30982	0.000	0.00000	0.000	72.6	71.3	0	0
SEP	14.28552	-0.013	0.00000	0.000	72.7	70.2	0	0
OCT	0.03250	-0.838	0.00000	0.000	88.2	67.8	0	0
NOV	0.01320	-6.416	0.00000	0.000	74.1	67.5	0	0
DEC	0.00234	-16.045	0.00000	0.000	70.6	67.5	0	0

FORT BRAGG HAMMERHEAD BARRACK BASELINE DOE-2.1C 10/19/1995 14:12:48 SDL RUN 1
GREEN
R[illegible] SS-F ZONE DEMAND SUMMARY IN FANCOIL FOR 2ROOM-N WEATHER FILE- TMY NASHVILLE, TN

	----DEMANDS-----		--BASEBOARDS---		--TEMPERATURES--		--LOADS NOT MET--	
MONTH	HEAT EXTRACTION ENERGY (MBTU)	HEAT ADDITION ENERGY (MBTU)	BASEBOARD ENERGY (MBTU)	MAXIMUM BASEBOARD LOAD (KBTU/HR)	MAXIMUM ZONE TEMP (F)	MINIMUM ZONE TEMP (F)	HOURS UNDER HEATED	HOURS UNDER COOLED
JAN	0.00000	-17.927	0.00000	0.000	68.0	67.4	0	0
FEB	0.00000	-13.550	0.00000	0.000	70.0	67.5	0	0
MAR	0.00001	-9.665	0.00000	0.000	71.5	67.6	0	0
APR	1.23049	-0.298	0.00000	0.000	71.7	53.6	0	0
MAY	6.03845	-0.123	0.00000	0.000	72.1	63.4	0	0
JUN	12.51480	0.000	0.00000	0.000	72.3	71.0	0	0
JUL	15.36534	0.000	0.00000	0.000	72.3	71.2	0	0
A[illegible]	13.21236	0.000	0.00000	0.000	72.2	71.2	0	0
SEP	7.85043	-0.041	0.00000	0.000	72.1	69.0	0	0
OCT	0.00110	-2.750	0.00000	0.000	81.7	67.8	0	0
NOV	0.00000	-8.991	0.00000	0.000	70.9	67.6	0	0
DEC	0.00000	-17.898	0.00000	0.000	69.0	67.5	0	0

FORT BRAGG HAMMERHEAD BARRACK BASELINE DOE-2.1C 10/19/1995 14:12:48 SDL RUN 1
GREEN
RE[illegible] SS-F ZONE DEMAND SUMMARY IN FANCOIL FOR 3ROOM-S WEATHER FILE- TMY NASHVILLE, TN

	----DEMANDS-----		--BASEBOARDS---		--TEMPERATURES--		--LOADS NOT MET--	
MONTH	HEAT EXTRACTION ENERGY (MBTU)	HEAT ADDITION ENERGY (MBTU)	BASEBOARD ENERGY (MBTU)	MAXIMUM BASEBOARD LOAD (KBTU/HR)	MAXIMUM ZONE TEMP (F)	MINIMUM ZONE TEMP (F)	HOURS UNDER HEATED	HOURS UNDER COOLED
JAN	0.00000	-44.635	0.00000	0.000	67.9	66.6	0	0
FEB	0.00140	-34.093	0.00000	0.000	71.0	66.8	0	0
MAR	0.00542	-24.815	0.00000	0.000	72.2	66.9	0	0
APR	2.68889	-0.355	0.00000	0.000	72.4	51.7	0	0
MAY	9.87404	-0.183	0.00000	0.000	72.8	59.6	0	0
JUN	20.76617	-0.019	0.00000	0.000	73.4	69.2	0	0
JUL	27.47034	-0.003	0.00000	0.000	73.6	70.3	0	0
A[illegible]	24.81233	-0.005	0.00000	0.000	73.7	70.4	0	0
SEP	16.82538	-0.069	0.00000	0.000	73.8	67.8	0	0
OCT	0.05333	-6.442	0.00000	0.000	86.2	67.4	0	0
NOV	0.00806	-21.483	0.00000	0.000	72.6	67.0	0	0
DEC	0.00000	-44.154	0.00000	0.000	68.6	66.8	0	0

FORT BRAGG HAMMERHEAD BARRACK   BASELINE   DOE-2.1C 10/19/1995   14:12:48 SDL RUN 1
GREEN
REPORT- SS-F ZONE DEMAND SUMMARY IN FANCOIL   FOR 3ROOM-N   WEATHER FILE- TMY NASHVILLE, TN

	----DEMANDS-----		--BASEBOARDS---		--TEMPERATURES--		--LOADS NOT MET--	
MONTH	HEAT EXTRACTION ENERGY (MBTU)	HEAT ADDITION ENERGY (MBTU)	BASEBOARD ENERGY (MBTU)	MAXIMUM BASEBOARD LOAD (KBTU/HR)	MAXIMUM ZONE TEMP (F)	MINIMUM ZONE TEMP (F)	HOURS UNDER HEATED	HOURS UNDER COOLED
JAN	0.00000	-42.186	0.00000	0.000	67.9	66.8	0	0
FEB	0.00000	-33.247	0.00000	0.000	69.8	67.0	0	0
MAR	0.00010	-25.217	0.00000	0.000	71.1	67.1	0	0
APR	1.34058	-0.359	0.00000	0.000	72.1	50.1	0	0
MAY	7.50497	-0.185	0.00000	0.000	72.6	58.7	0	0
JUN	17.56245	-0.016	0.00000	0.000	72.9	69.4	0	0
JUL	22.90514	-0.003	0.00000	0.000	72.9	70.4	0	0
AUG	18.78151	-0.008	0.00000	0.000	72.8	70.1	0	0
SEP	10.42329	-0.098	0.00000	0.000	72.7	66.2	0	0
OCT	0.01403	-9.259	0.00000	0.000	81.1	67.4	0	0
NOV	0.00000	-23.122	0.00000	0.000	70.2	67.1	0	0
DEC	0.00000	-41.900	0.00000	0.000	68.4	66.9	0	0

FORT BRAGG HAMMERHEAD BARRACK BASELINE DOE-2.1C 10/19/1995 14:12:48 PDL RUN 1
GREEN
RE PV-A EQUIPMENT SIZES WEATHER FILE- TMY NASHVILLE, TN

EQUIPMENT	SIZE (MBTU/)	NUMBER INSTD	AVAIL	SIZE (MBTU/)	NUMBER INSTD	AVAIL	SIZE (MBTU/)	NUMBER INSTD	AVAIL	SIZE (MBTU/)	NUMBER INSTD	AVAIL	SIZE (MBTU/)	NUMBER INSTD	AVAIL	SIZE (MBTU/)	NUMBER INSTD	AVAIL
DIESEL-GEN	0.055	1	1															

FORT BRAGG HAMMERHEAD BARRACK BASELINE DOE-2.1C 10/19/1995 14:12:48 PDL RUN 1
GREEN

REPORT- PS-A PLANT ENERGY UTILIZATION SUMMARY WEATHER FILE- TMY NASHVILLE, TN

	SITE ENERGY												SOURCE
	2	3	4	5	6	7	8	9	10	11	12	13	14
MONTH	TOTAL HEAT LOAD	TOTAL COOLING LOAD	TOTAL ELECTR LOAD	RCVRED ENERGY	WASTED RCVRABL ENERGY	HEAT INPUT COOLING	ELEC INPUT COOLING	FUEL INPUT HEATING	ELEC INPUT HEATING	FUEL INPUT ELECT	TOTAL FUEL INPUT	TOTAL SITE ENERGY	TOTAL SOURCE ENERGY
JAN	222.4	0.0	17.2 5.0E	0.0	0.0	0.0	0.0 0.0E	0.0	1.9 0.6E	0.0	0.0	239.6	422.4
FEB	174.4	0.0	15.3 4.5E	0.0	0.0	0.0	0.0 0.0E	0.0	1.7 0.5E	0.0	0.0	189.7	336.7
MAR	131.4	0.0	17.0 5.0E	0.0	0.0	0.0	0.0 0.0E	0.0	1.9 0.6E	0.0	0.0	148.3	269.9
APR	0.0	16.8	16.6 4.9E	0.0	0.0	0.0	1.6 0.5E	0.0	0.0 0.0E	0.0	0.0	33.4	61.0
MAY	0.0	58.1	18.0 5.3E	0.0	0.0	0.0	2.8 0.8E	0.0	0.0 0.0E	0.0	0.0	76.2	93.0
JUN	0.0	126.1	18.1 5.3E	0.0	0.0	0.0	3.6 1.1E	0.0	0.0 0.0E	0.0	0.0	144.1	138.4
JUL	0.0	184.1	19.1 5.6E	0.0	0.0	0.0	3.8 1.1E	0.0	0.0 0.0E	0.0	0.0	203.2	180.0
AUG	0.0	157.8	19.1 5.6E	0.0	0.0	0.0	3.8 1.1E	0.0	0.0 0.0E	0.0	0.0	176.9	162.5
SEP	0.0	95.2	17.9 5.2E	0.0	0.0	0.0	3.4 1.0E	0.0	0.0 0.0E	0.0	0.0	113.0	117.1
OCT	58.3	0.0	17.2 5.0E	0.0	0.0	0.0	0.0 0.0E	0.0	1.9 0.6E	0.0	0.0	75.5	148.8
NOV	118.7	0.0	16.1 4.7E	0.0	0.0	0.0	0.0 0.0E	0.0	1.9 0.5E	0.0	0.0	134.9	246.3
DEC	220.5	0.0	17.0 5.0E	0.0	0.0	0.0	0.0 0.0E	0.0	1.9 0.6E	0.0	0.0	237.5	418.6
	=======	=======	=======	=======	=======	=======	=======	=======	=======	=======	=======	=======	=======
	925.7	638.2	208.6 61.1E	0.0	0.0	0.0	18.9 5.5E	0.0	11.3 3.3E	0.0	0.0	1772.5	2594.7

NOTE-- ALL ENTRIES ARE IN MBTU EXCEPT
ENTRIES FOLLOWED BY E ARE IN MWH (THOUSANDS OF KWH)

FORT BRAGG HAMMERHEAD BARRACK BASELINE DOE-2.1C 10/19/1995 14:12:48 PDL RUN 1
GREEN
REPORT- PS-D PLANT LOADS SATISFIED WEATHER FILE- TMY NASHVILLE, TN

HEATING INPUTS	MBTU SUPPLIED	PCT OF TOTAL LOAD
STEAM	925.7	100.0
LOAD SATISFIED	925.7	100.0
TOTAL LOAD ON PLANT	925.7	

COOLING INPUTS	MBTU SUPPLIED	PCT OF TOTAL LOAD
CHILLED-WATER	638.2	100.0
LOAD SATISFIED	638.2	100.0
TOTAL LOAD ON PLANT	638.2	

ELECTRICAL INPUTS	MBTU SUPPLIED	PCT OF TOTAL LOAD
DIESEL-GEN	0.0	0.0
ELECTRICITY	208.6	100.0
LOAD SATISFIED	208.6	100.0
TOTAL LOAD ON PLANT	208.6	

FORT BRAGG HAMMERHEAD BARRACK BASELINE DOE-2.1C 10/19/1995 14:12:48 PDL RUN 1
GREEN
REP - PS-D PLANT LOADS SATISFIED WEATHER FILE- TMY NASHVILLE, TN
(CONTINUED)

SUMMARY OF LOADS MET

TYPE OF LOAD	TOTAL LOAD (MBTU)	LOAD SATISFIED (MBTU)	TOTAL OVERLOAD (MBTU)	PEAK OVERLOAD (MBTU)	HOURS OVERLOADED
HEATING INPUTS	925.7	925.7	0.000	0.000	0
COOLING INPUTS	638.2	638.2	0.000	0.000	0
ELECTRICAL INPUTS	208.6	208.6	0.000	0.000	0

FORT BRAGG HAMMERHEAD BARRACK BASELINE DOE-2.1C 10/19/1995 14:12:48 PDL RUN 1
GREEN
REPORT- BEPS ESTIMATED BUILDING ENERGY PERFORMANCE WEATHER FILE- TMY NASHVILLE, TN

ENERGY TYPE IN SITE MBTU -	STEAM	CHILLED-WATE	ELECTRICITY	DIESEL-OIL
CATEGORY OF USE				
SPACE HEAT	925.72	0.00	0.00	0.00
SPACE COOL	0.00	638.19	0.00	0.00
HVAC AUX	0.00	0.00	63.65	0.00
DOM HOT WTR	0.00	0.00	0.00	0.00
AUX SOLAR	0.00	0.00	0.00	0.00
LIGHTS	0.00	0.00	117.78	0.00
VERT TRANS	0.00	0.00	0.00	0.00
MISC EQUIP	0.00	0.00	27.15	0.00
TOTAL	925.72	638.19	208.58	0.00

TOTAL SITE ENERGY	1772.49 MBTU	85.3 KBTU/SQFT-YR GROSS-AREA	85.3 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY	2594.70 MBTU	124.9 KBTU/SQFT-YR GROSS-AREA	124.9 KBTU/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.0
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.0

NOTE ELECTRICITY AND/OR FUEL USED TO GENERATE ELECTRICITY IS APPORTIONED BASED ON THE YEARLY DEMAND. ALL OTHER ENERGY TYPE

ECO
MODEL
INPUT

```
INPUT LOADS ..
  TITLE LINE-1 *FORT BRAGG HAMMERHEAD BARRACK* ..
  TITLE LINE-2 *ECO : TEMP SETBACK/REDUCED OA* ..
  TITLE LINE-3 *GREEN* ..

  RUN-PERIOD FROM JAN 1 1991 THRU DEC 31 1991 ..
  ABORT ERRORS ..
  DIAGNOSTIC COMMENTS NARROW ..
  LOADS-REPORT V=(LV-A,LV-B,LV-D,LV-I) S=(LS-A,LS-C,LS-D) ..

  BUILDING-LOCATION  D-S=YES  AZ=0  T-Z=5  ALT=941 ..

$ *********************** CONSTRUCTION INPUTS ***********************

  BLKWALL   = LAYERS MATERIAL=(HF-A2,HF-C8,HF-E1) ..
  WALL1     = CONS LAYERS=BLKWALL ABS=0.65 RO=2 ..
  WINDOW1   = GLASS-TYPE  PANES=1  GLASS-TYPE-CODE=9 ..
  BUROOF    = LAYERS MATERIAL=(HF-E2, HF-C5, HF-E4, HF-E5) ..
  ROOF1     = CONS LAYERS=BUROOF ABS=0.35 RO=1 ..
  FLOOR1    = CONS  U=0.5  ..

$ OCCUPANCY SCHEDULE FOR BARRACKS ROOMS
  OC-DS2    = D-SCH (1,7)(1)(8,16)(.05)(17,24)(1) ..
  OC-WEHDS2= D-SCH (1,7)(1)(8,17)(0.25)(18,24)(1) ..
  OC-WS2    = W-SCH (WD) OC-DS2 (WEH) OC-WEHDS2 ..
  OC-SCH2   = SCHEDULE THRU DEC 31 OC-WS2 ..

$ OCCUPANCY SCHEDULE FOR FIRST FLOOR DAYROOM
  OC-DS1    = D-SCH (1,7)(.1)(8,16)(.25)(17,24)(.1) ..
  OC-WEHDS1= D-SCH (1,7)(.1)(8,17)(0.5)(18,24)(.1) ..
  OC-WS1    = W-SCH (WD) OC-DS1 (WEH) OC-WEHDS1 ..
  OC-SCH1   = SCHEDULE THRU DEC 31 OC-WS1 ..

$ LIGHTING SCHEDULE FOR BARRACKS ROOMS
  LT-DS2    = D-SCH (1,6)(.1)(7,8)(1)(9,17)(.15)(18,24)(1) ..
  LT-WEHDS2= D-SCH (1,7)(.1)(8,24)(.2) ..
  LT-WS2    = W-SCH (WD) LT-DS2 (WEH) LT-WEHDS2 ..
  LT-SCH2   = SCHEDULE THRU DEC 31 LT-WS2 ..

$ LIGHTING SCHEDULE FOR FIRST FLOOR DAYROOM
  LT-DS1    = D-SCH (1,6)(.1)(7,8)(1)(9,17)(.25)(18,24)(1) ..
  LT-WEHDS1= D-SCH (1,7)(.1)(8,24)(.5) ..
  LT-WS1    = W-SCH (WD) LT-DS1 (WEH) LT-WEHDS1 ..
  LT-SCH1   = SCHEDULE THRU DEC 31 LT-WS1 ..

$ EQUIPMENT SCHEDULE FOR ALL AREAS
  EQ-DS     = D-SCH (1,7)(.1)(8,16)(.1)(17,24)(.8) ..
  EQ-WEHDS  = D-SCH (1,7)(.1)(8,16)(.2)(17,24)(.6) ..
  EQ-WS     = W-SCH (WD) EQ-DS (WEH) EQ-WEHDS ..
  EQ-SCH    = SCHEDULE THRU DEC 31 EQ-WS ..

$ ************************* SPACE CONDITIONS *********************

  BARRACK=S-C
  P-SCH=OC-SCH2  P-H-L=105  P-H-S=225  N-O-P=20  L-SCH=LT-SCH2
  L-T=REC-FLUOR-NV  L-W=0.5  L-T-S=1.0  E-SCH=EQ-SCH   E-KW=0.4
  INF-METHOD=AIR-CHANGE  AIR-CHANGES/HR=0.5 ..

  YRM=S-C
  P-SCH=OC-SCH1  P-H-L=105  P-H-S=225  N-O-P=4  L-SCH=LT-SCH1
  L-T=REC-FLUOR-NV  L-W=0.5  L-T-S=1.0  E-SCH=EQ-SCH   E-KW=.4
  INF-METHOD=AIR-CHANGE  AIR-CHANGES/HR=0.5 ..

  SET-DEFAULT FOR EXTERIOR-WALL CONS=WALL1 ..
```

```
   SET-DEFAULT FOR WINDOW  GLASS-TYPE=WINDOW1 ..
   SET-DEFAULT FOR INTERIOR-WALL CONS=FLOOR1  ..

$  *************************** SPACE INPUT ************************

   1ST FLOOR

   DAYROOM=S           X=0    Y=0    Z=0    AZ=0    A=2556  V=20448  S-C=DAYRM ..
   D-SWALL=E-W         X=0    Y=0    H=8    W=75    Z=0   AZ=180 ..
   D-SWIND1=WINDOW     X=5    Y=0    H=5    W=4 ..
   D-SWIND2=WINDOW     X=16   Y=0    H=5    W=4 ..
   D-SWIND3=WINDOW     X=29   Y=0    H=5    W=4 ..
   D-SWIND4=WINDOW     X=39   Y=0    H=5    W=4 ..
   D-SWIND5=WINDOW     X=53   Y=0    H=5    W=4 ..
   D-SWIND6=WINDOW     X=64   Y=0    H=5    W=4 ..

   1ROOM-S=S           X=95   Y=0    Z=0    AZ=0  A=2295   V=18360  S-C=BARRACK ..
   1RS-SWALL=E-W       X=0    Y=0    H=8    W=153  Z=0   AZ=180 ..
   1RS-SWW1=WINDOW     X=10   Y=0    H=5    W=4   M=12 ..
   1RS-EWALL=E-W       X=24   Y=0    H=8    W=24  Z=0   AZ=90 ..

   2ROOM-S=S           X=0    Y=0    Z=10   AZ=0  A=3735    V=29880  S-C=BARRACK ..
   2RS-SWALL=E-W       X=0    Y=0    H=8    W=249 Z=0   AZ=180 ..
   2RS-SWW1=WINDOW     X=5    Y=0    H=5    W=4    M=20  ..
   2RS-EWALL=E-W       X=24   Y=0    H=8    W=24  Z=0   AZ=90 ..
   1FLOOR=I-W          A=3735    TILT=0     N-T=1ROOM-S ..
   2FLOOR=I-W          A=3735    TILT=0     N-T=3ROOM-S ..

   3ROOM-S=S           X=0    Y=0    Z=20   AZ=0  A=3735  V=29880  S-C=BARRACK ..
   3RS-SWALL=E-W       X=0    Y=0    H=8    W=249 Z=0   AZ=180 ..
   3RS-SWW1=WINDOW     X=5    Y=0    H=5    W=4   M=20   ..
   3RS-EWALL=E-W       X=24   Y=0    H=8    W=24  Z=0   AZ=90 ..
   1ROOF=E-W           X=0    Y=0    Z=10   H=24  W=249   CONS=ROOF1  TILT=0  ..

   1ROOM-N=S           X=75   Y=22   Z=0    AZ=0  A=2220  V=17760  S-C=BARRACK ..
   1RN-NWALL=E-W       X=14   Y=15   H=8    W=150 Z=0   AZ=0 ..
   1RN-NWW1=WINDOW     X=5    Y=0    H=5    W=4    M=12  ..
   1RN-EWALL=E-W       X=24   Y=0    H=8    W=24  Z=0   AZ=90 ..

   2ROOM-N=S           X=0    Y=22   Z=10   AZ=0  A=3120  V=24960  S-C=BARRACK ..
   2RN-NWALL=E-W       X=25   Y=15   H=8    W=208 Z=0   AZ=0 ..
   2RN-NWW1=WINDOW     X=5    Y=0    H=5    W=4    M=18  ..
   2RN-EWALL=E-W       X=24   Y=0    H=8    W=24  Z=0   AZ=90 ..
   3FLOOR=I-W          A=3120    TILT=0     N-T=1ROOM-N ..
   4FLOOR=I-W          A=3120    TILT=0     N-T=3ROOM-N ..

   3ROOM-N=S           X=0    Y=22   Z=20   AZ=0  A=3120  V=24960  S-C=BARRACK ..
   3RN-NWALL=E-W       X=25   Y=15   H=8    W=208 Z=0   AZ=0 ..
   3RN-NWW1=WINDOW     X=5    Y=0    H=5    W=4    M=18  ..
   3RN-EWALL=E-W       X=24   Y=0    H=8    W=24  Z=0   AZ=90 ..
   2ROOF=E-W           X=0    Y=0    Z=10   H=24  W=208   CONS=ROOF1  TILT=0  ..

END ..
COMPUTE LOADS ..

$  ********************** SYSTEMS INPUT ****************************

INPUT SYSTEMS ..
SYSTEMS-REPORT V=(SV-A,SV-B) S=(SS-A,SS-B,SS-D,SS-F,SS-H,
                                SS-I,SS-J,SS-K,SS-L,SS-M) ..

   HEATING AND COOLING DAY SCHEDULES

   H-1=D-SCH(1,7)(67) (8,17)(57) (18,24)(67) ..
   HW-1=W-SCH (ALL) H-1 ..
   H-2=D-SCH(1,24)(20) ..
```

```
   HW-2=W-SCH (ALL) H-2 ..
   HEAT1=SCHEDULE THRU MAR 31 HW-1
                  THRU SEP 30 HW-2
                  THRU DEC 31 HW-1 ..

   C-1=D-SCH(1,7)(72) (8,17)(82) (18,24)(72) ..
   CW-1=W-SCH (ALL) C-1 ..
   C-2=D-SCH(1,24)(100) ..
   CW-2=W-SCH (ALL) C-2 ..
   COOL1=SCHEDULE THRU MAR 31 CW-2
                  THRU SEP 30 CW-1
                  THRU DEC 31 CW-2 ..

$  MIN-AIR-SCH

   M-A-S-D=D-SCH(1,7)(.2) (8,17)(0) (17,24)(.2)  ..
   M-A-S-W=W-SCH(ALL) M-A-S-D  ..
   M-A-S1=SCHEDULE THRU DEC 31 M-A-S-W  ..


$  HEATING AVAILABILITY

   H-A-SCH1=D-SCH(1,24) (1) ..
   H-A-SCH2=D-SCH(1,24) (0) ..
   H-A-WSCH1=W-SCH(ALL) H-A-SCH1 ..
   H-A-WSCH2=W-SCH(ALL) H-A-SCH2 ..
   HSCH1=SCHEDULE THRU MAR 31 H-A-WSCH1
                  THRU SEP 30 H-A-WSCH2
                  THRU DEC 31 H-A-WSCH1 ..

$ COOLING AVAILABILITY

  C-A-SCH1=D-SCH(1,24) (0) ..
  C-A-SCH2=D-SCH(1,24) (1) ..
  C-A-WSCH1=W-SCH(ALL) C-A-SCH1 ..
  C-A-WSCH2=W-SCH(ALL) C-A-SCH2 ..
  CSCH1=SCHEDULE THRU MAR 31 C-A-WSCH1
                 THRU SEP 30 C-A-WSCH2
                 THRU DEC 31 C-A-WSCH1 ..

$  FAN SCHEDULE
   F-1=D-SCH (1,7)(1) (8,17)(0) (17,24)(1)  ..
   FW-1=W-SCH (ALL) F-1 ..
   FAN1=SCHEDULE THRU DEC 31 FW-1 ..

$  ************************** ZONE CONTROL **************************

   ZNCTL=Z-C  D-H-T=67  H-T-SCH=HEAT1  D-C-T=72  C-T-SCH=COOL1 ..

$  ************************** ZONE INPUTS ****************************

   DAYROOM=Z    Z-C=ZNCTL   A-CFM=2800 ..
   1ROOM-S=Z    Z-C=ZNCTL   A-CFM=2200  ..
   1ROOM-N=Z    Z-C=ZNCTL   A-CFM=2200  ..
   2ROOM-S=Z    Z-C=ZNCTL   A-CFM=2200  ..
   2ROOM-N=Z    Z-C=ZNCTL   A-CFM=2200  ..
   3ROOM-S=Z    Z-C=ZNCTL   A-CFM=2200  ..
   3ROOM-N=Z    Z-C=ZNCTL   A-CFM=2200  ..

$  ************************** SYSTEM INPUT **************************

   COIL=SYSTEM
   S-TYPE=TPFC   S-CFM=9100   MIN-S-T=45  MAX-S-T=150  M-A-SCH=M-A-S1
                 F-SCH=FAN1   HEAT-SOURCE=HOT-WATER  N-C-C=CYCLE-ON-ANY
                 H-SCH=HSCH1   C-SCH=CSCH1   Z-N= (DAYROOM,
                      1ROOM-S, 1ROOM-N, 2ROOM-S, 2ROOM-N, 3ROOM-S,
```

```
                    3ROOM-N)
END ..
COMPUTE SYSTEMS ..

$ ************************** PLANT PROGRAM **************************
$ INPUT TO SIMULATE A CENTRAL HOT WATER/CHILL WATER PLANT

INPUT PLANT ..
   DUMMY=PLANT-EQUIPMENT  TYPE=DIESEL-GEN  SIZE=0 ..

   ELEC=LOAD-ASSIGNMENT
   TYPE=ELECTRICAL   O-M=RUN-NEEDED  L-R=200.0  P-E=UTILITY N=1
                                     L-R=200.1  P-E=DUMMY   N=1 ..

   BUYCHILL=LOAD-ASSIGNMENT
   TYPE=COOLING      O-M=RUN-NEEDED  L-R=3.0    P-E=UTILITY N=1 ..

   BUYSTEAM=LOAD-ASSIGNMENT
   TYPE=HEATING      O-M=RUN-NEEDED  L-R=0.6    P-E=UTILITY N=1 ..

   LOAD-MANAGEMENT
   PRED-L-R=999      L-A=(BUYSTEAM,BUYCHILL,ELEC) ..

   ENERGY-COST       R=ELECTRICITY   U=3413     U-C=0.045 ..
   ENERGY-COST       R=CHILLED-WATER U=1000000  U-C=5.16 ..
   ENERGY-COST       R=STEAM         U=1000000  U-C=5.5 ..
   PLANT-REPORT      V=(PV-A) S=(PS-A,PS-D,BEPS) ..
END ..
COMPUTE PLANT ..
STOP ..
```

ECO
MODEL
OUTPUT

```
****    ***   *****          ***      *     ****
*   *  *   *  *             *   *    **     *
*   *  *   *  *****  ***       *      *     *
*   *  *   *  *              **       *     *
****    ***   *****         ***** *  ***    ****
```

B U I L D I N G   E N E R G Y   A N A L Y S I S   P R O G R A M

DEVELOPED BY
LAWRENCE BERKELEY LABORATORY/UNIVERSITY OF CALIFORNIA

WITH MAJOR SUPPORT FROM
UNITED STATES DEPARTMENT OF ENERGY
ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE ENERGY
OFFICE OF BUILDINGS ENERGY RESEARCH AND DEVELOPMENT
BUILDING SYSTEMS DIVISION

LBL RELEASE AUG 1986

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M   M  IIIII   CCCC   RRRR    OOO        DDDD    OOO   EEEEE   222       222     1    CCCC
MM MM    I    C       R   R  O   O       D   D  O   O  E      2   2     2   2   11   C
M M M    I    C       RRRR   O   O  ===  D   D  O   O  EEEEE     2  ===    2     1   C
M   M    I    C       R  R   O   O       D   D  O   O  E       22        22      1   C
M   M  IIIII   CCCC   R   R   OOO        DDDD    OOO   EEEEE  22222     22222 * 111   CCCC
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ACROSOFT INTERNATIONAL,INC. / DENVER, COLORADO

FORT BRAGG HAMMERHEAD BARRACK ECO : TEMP SETBACK/REDUCED OA DOE-2.1C 10/19/1995 14:20:40 LDL RUN 1
GREEN
REP - LV-A GENERAL PROJECT AND BUILDING INPUT WEATHER FILE- TMY NASHVILLE, TN

PERIOD OF STUDY

STARTING DATE	ENDING DATE	NUMBER OF DAYS
1 JAN 1991	31 DEC 1991	365

SITE CHARACTERISTIC DATA

STATION NAME	LATITUDE (DEG)	LONGITUDE (DEG)	ALTITUDE (FT)	TIME ZONE	BUILDING AZIMUTH (DEG)
TMY NASHVILLE, TN	36.1	86.4	941.	5 EST	0.0

FORT BRAGG HAMMERHEAD BARRACK ECO : TEMP SETBACK/REDUCED OA DOE-2.1C 10/19/1995 14:20:40 LDL RUN 1
GREEN
REP · LV-B SUMMARY OF SPACES OCCURRING IN THE PROJECT WEATHER FILE- TMY NASHVILLE, TN

NUMBER OF SPACES 7 EXTERIOR 7 INTERIOR 0

SPACE	SPACE MULT.	SPACE TYPE	AZIMUTH	LIGHTING (WATTS/ SQFT)	PEOPLE	EQUIP. (WATTS/ SQFT)	INFILTRATION METHOD	AIR CHANGES PER HOUR	FLOW RATE (CFM/SQFT)	AREA (SQFT)	VOLUME (CUFT)
DAYROOM	1.00	EXT	0.0	0.50	4.0	0.00	AIR-CHANGE	0.50	0.00	2556.	20448.
1ROOM-S	1.00	EXT	0.0	0.50	20.0	0.00	AIR-CHANGE	0.50	0.00	2295.	18360.
2ROOM-S	1.00	EXT	0.0	0.50	20.0	0.00	AIR-CHANGE	0.50	0.00	3735.	29880.
3ROOM-S	1.00	EXT	0.0	0.50	20.0	0.00	AIR-CHANGE	0.50	0.00	3735.	29880.
1ROOM-N	1.00	EXT	0.0	0.50	20.0	0.00	AIR-CHANGE	0.50	0.00	2220.	17760.
2ROOM-N	1.00	EXT	0.0	0.50	20.0	0.00	AIR-CHANGE	0.50	0.00	3120.	24960.
3ROOM-N	1.00	EXT	0.0	0.50	20.0	0.00	AIR-CHANGE	0.50	0.00	3120.	24960.
					------					--------	--------
BUILDING TOTALS					124.0					20781.00	166248.00

FORT BRAGG HAMMERHEAD BARRACK   ECO : TEMP SETBACK/REDUCED OA   DOE-2.1C 10/19/1995 14:20:40 LDL RUN 1
GREEN
REPORT- LV-D DETAILS OF EXTERIOR SURFACES IN THE PROJECT   WEATHER FILE- TMY NASHVILLE, TN

NUMBER OF EXTERIOR SURFACES 15   RECTANGULAR 15   OTHER 0

SURFACE	SPACE	- - - - G L A S S - - - - U-VALUE (BTU/HR - SQFT)	AREA (SQFT)	- - - - W A L L - - - - U-VALUE (BTU/HR - SQFT)	AREA (SQFT)	- W A L L + G L A S S - U-VALUE (BTU/HR - SQFT)	AREA (SQFT)	AZIMUTH
1RN-NWALL	1ROOM-N	1.02	240.00	0.39	960.00	0.51	1200.00	NORTH
2RN-NWALL	2ROOM-N	1.02	360.00	0.39	1304.00	0.52	1664.00	NORTH
3RN-NWALL	3ROOM-N	1.02	360.00	0.39	1304.00	0.52	1664.00	NORTH
1RS-EWALL	1ROOM-S	0.00	0.00	0.39	192.00	0.39	192.00	EAST
1RN-EWALL	1ROOM-N	0.00	0.00	0.39	192.00	0.39	192.00	EAST
2RS-EWALL	2ROOM-S	0.00	0.00	0.39	192.00	0.39	192.00	EAST
2RN-EWALL	2ROOM-N	0.00	0.00	0.39	192.00	0.39	192.00	EAST
3[illegible]ALL	3ROOM-S	0.00	0.00	0.39	192.00	0.39	192.00	EAST
3RN-EWALL	3ROOM-N	0.00	0.00	0.39	192.00	0.39	192.00	EAST
3RS-SWALL	3ROOM-S	1.02	400.00	0.39	1592.00	0.51	1992.00	SOUTH
D-SWALL	DAYROOM	1.02	120.00	0.39	480.00	0.51	600.00	SOUTH
2RS-SWALL	2ROOM-S	1.02	400.00	0.39	1592.00	0.51	1992.00	SOUTH
1RS-SWALL	1ROOM-S	1.02	240.00	0.39	984.00	0.51	1224.00	SOUTH
1ROOF	3ROOM-S	0.00	0.00	0.25	5976.00	0.25	5976.00	ROOF
2ROOF	3ROOM-N	0.00	0.00	0.25	4992.00	0.25	4992.00	ROOF

FORT BRAGG HAMMERHEAD BARRACK ECO : TEMP SETBACK/REDUCED OA DOE-2.1C 10/19/1995 14:20:40 LDL RUN 1
GREEN
REP--- LV-D DETAILS OF EXTERIOR SURFACES IN THE PROJECT WEATHER FILE- TMY NASHVILLE, TN
--(CONTINUED)--------

	AVERAGE U-VALUE/GLASS (BTU/HR - SQFT)	AVERAGE U-VALUE/WALLS (BTU/HR - SQFT)	AVERAGE U-VALUE WALLS+GLASS (BTU/HR - SQFT)	GLASS AREA (SQFT)	OPAQUE AREA (SQFT)	GLASS+OPAQUE AREA (SQFT)
NORTH	1.02	0.39	0.52	960.00	3568.00	4528.00
EAST	0.00	0.39	0.39	0.00	1152.00	1152.00
SOUTH	1.02	0.39	0.51	1160.00	4648.00	5808.00
ROOF	0.00	0.25	0.25	0.00	10968.00	10968.00
ALL WALLS	1.02	0.39	0.50	2120.00	9368.00	11488.00
WALLS+ROOFS	1.02	0.31	0.38	2120.00	20336.00	22456.00
BUILDING	1.02	0.31	0.38	2120.00	20336.00	22456.00

FORT BRAGG HAMMERHEAD BARRACK ECO : TEMP SETBACK/REDUCED OA DOE-2.1C 10/19/1995 14:20:40 LDL RUN 1
GREEN
REP^^^- LV-I DETAILS OF CONSTRUCTIONS OCCURRING IN THE PROJECT WEATHER FILE- TMY NASHVILLE, TN

NUMBER OF CONSTRUCTIONS 3 DELAYED 2 QUICK 1

CONSTRUCTION NAME	U-VALUE (BTU/HR - SQFT)	SURFACE ABSORPTANCE	SURFACE ROUGHNESS INDEX	SURFACE TYPE	NUMBER OF RESPONSE FACTORS
WALL1	0.42	0.65	2	DELAYED	13
ROOF1	0.26	0.35	1	DELAYED	5
FLOOR1	0.50	0.70	3	QUICK	0

FORT BRAGG HAMMERHEAD BARRACK ECO : TEMP SETBACK/REDUCED OA DOE-2.1C 10/19/1995 14:20:40 LDL RUN 1
GREEN
REPORT- LS-A SPACE PEAK LOADS SUMMARY WEATHER FILE- TMY NASHVILLE, TN

SPACE NAME	MULTIPLIER SPACE	MULTIPLIER FLOOR	COOLING LOAD (KBTU/HR)	TIME OF PEAK	DRY-BULB	WET-BULB	HEATING LOAD (KBTU/HR)	TIME OF PEAK	DRY-BULB	WET-BULB
DAYROOM	1.	1.	18.625	OCT 12 4 PM	87.F	71.F	-29.854	JAN 12 8 AM	14.F	12.F
1ROOM-S	1.	1.	35.691	SEP 5 6 PM	89.F	75.F	-45.661	JAN 12 8 AM	14.F	12.F
2ROOM-S	1.	1.	54.580	SEP 5 6 PM	89.F	75.F	-73.960	JAN 12 8 AM	14.F	12.F
3ROOM-S	1.	1.	87.807	SEP 5 6 PM	89.F	75.F	-154.453	JAN 12 8 AM	14.F	12.F
1ROOM-N	1.	1.	29.330	JUL 9 6 PM	89.F	76.F	-47.252	JAN 12 8 AM	14.F	12.F
2ROOM-N	1.	1.	39.201	JUL 9 6 PM	89.F	76.F	-66.487	JAN 12 8 AM	14.F	12.F
3ROOM-N	1.	1.	70.215	JUN 30 6 PM	92.F	74.F	-133.727	JAN 12 8 AM	14.F	12.F
SUM			335.449				-551.395			
BUILDING PEAK			319.670	JUL 9 6 PM	89.F	76.F	-551.395	JAN 12 8 AM	14.F	12.F

FORT BRAGG HAMMERHEAD BARRACK ECO : TEMP SETBACK/REDUCED OA DOE-2.1C 10/19/1995 14:20:40 LDL RUN 1
GREEN
REPORT- LS-C BUILDING PEAK LOAD COMPONENTS WEATHER FILE- TMY NASHVILLE, TN

*** BUILDING ***

FLOOR AREA	20781	SQFT	1931	SQMT
VOLUME	166248	CUFT	4708	CUMT

	COOLING LOAD		HEATING LOAD	
TIME	JUL 9 6PM		JAN 12 8AM	
DRY-BULB TEMP	89F	32C	14F	-10C
WET-BULB TEMP	76F	24C	12F	-11C

	SENSIBLE (KBTU/H)	SENSIBLE (KW)	LATENT (KBTU/H)	LATENT (KW)	SENSIBLE (KBTU/H)	SENSIBLE (KW)
WALLS	74.407	21.792	0.000	0.000	-167.439	-49.039
ROOFS	65.880	19.294	0.000	0.000	-147.733	-43.267
GLASS CONDUCTION	41.822	12.249	0.000	0.000	-128.860	-37.740
GLASS SOLAR	54.658	16.008	0.000	0.000	11.746	3.440
DOOR	0.000	0.000	0.000	0.000	0.000	0.000
INTERNAL SURFACES	0.000	0.000	0.000	0.000	0.000	0.000
UNDERGROUND SURFACES	0.000	0.000	0.000	0.000	0.000	0.000
OCCUPANTS TO SPACE	21.846	6.398	12.642	3.703	12.798	3.748
LIGHT TO SPACE	23.191	6.792	0.000	0.000	10.036	2.939
EQUIPMENT TO SPACE	5.927	1.736	0.000	0.000	2.167	0.635
PROCESS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
INFILTRATION	31.940	9.354	58.339	17.086	-144.109	-42.206
TOTAL	319.670	93.623	70.981	20.788	-551.395	-161.490

TOTAL LOAD	390.650 KBTU/H	114.412 KW	-551.395 KBTU/H	-161.490 KW
TOTAL LOAD / AREA	18.80BTU/H.SQFT	59.262 W /SQMT	26.534BTU/H.SQFT	83.647 W /SQMT

NOTE 1)THE ABOVE LOADS EXCLUDE OUTSIDE VENTILATION AIR LOADS
---- 2)TIMES GIVEN IN STANDARD TIME FOR THE LOCATION IN CONSIDERATION

FORT BRAGG HAMMERHEAD BARRACK   ECO : TEMP SETBACK/REDUCED OA   DOE-2.1C 10/19/1995 14:20:40 LDL RUN 1
GREEN
REPORT- LS-D BUILDING MONTHLY LOADS SUMMARY   WEATHER FILE- TMY NASHVILLE, TN

	- - - C O O L I N G - - -						- - - H E A T I N G - - -						- - - E L E C - - -	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	0.66286	31	15	51.F	38.F	32.945	-165.981	12	8	14.F	12.F	-551.395	3646.	12.625
FEB	1.73368	10	14	68.F	51.F	62.324	-127.595	19	9	20.F	17.F	-456.031	3234.	12.625
MAR	4.31264	24	16	72.F	60.F	80.468	-98.553	30	4	23.F	20.F	-425.416	3578.	12.625
APR	23.98875	29	17	80.F	62.F	213.386	-42.077	9	6	33.F	32.F	-280.362	3576.	12.625
MAY	58.45398	9	17	85.F	68.F	276.842	-10.327	1	9	47.F	37.F	-182.291	3646.	12.625
JUN	103.59642	30	17	92.F	74.F	312.875	-0.429	14	5	55.F	53.F	-30.607	3441.	12.625
JUL	129.37885	9	17	89.F	76.F	319.670	-0.044	13	6	61.F	61.F	-11.948	3646.	12.625
AUG	117.47043	27	17	88.F	73.F	317.133	-0.093	23	8	67.F	61.F	-14.913	3646.	12.625
SEP	82.16725	5	17	89.F	75.F	312.280	-2.207	28	7	53.F	50.F	-73.330	3441.	12.625
OCT	33.05577	12	15	87.F	71.F	245.527	-35.323	28	8	43.F	38.F	-229.400	3646.	12.625
NOV	5.57543	18	18	66.F	58.F	83.578	-89.090	2	21	32.F	30.F	-388.359	3373.	12.625
DEC	0.90391	21	15	66.F	54.F	35.336	-165.211	24	3	23.F	20.F	-449.155	3578.	12.625
TOTAL	561.300						-736.929						42449.	
MAX						319.670						-551.395		12.625

FORT BRAGG HAMMERHEAD BARRACK ECO : TEMP SETBACK/REDUCED OA DOE-2.1C 10/19/1995 14:20:40 SDL RUN 1
GREEN FANCOIL WEATHER FILE- TMY NASHVILLE, TN
REPORT- SV-A SYSTEM DESIGN PARAMETERS

SYSTEM NAME	ALTITUDE MULTIPLIER
FANCOIL	1.030

SUPPLY FAN (CFM)	ELEC (KW)	DELTA-T (F)	RETURN FAN (CFM)	ELEC (KW)	DELTA-T (F)	OUTSIDE AIR RATIO	COOLING CAPACITY (KBTU/HR)	SENSIBLE (SHR)	HEATING CAPACITY (KBTU/HR)	COOLING EIR (BTU/BTU)	HEATING EIR (BTU/BTU)
16480.	0.000	0.2	0.	0.000	0.0	0.000	0.000	0.000	0.000	0.00	0.00

ZONE NAME	SUPPLY FLOW	EXHAUST FLOW	FAN (KW)	MINIMUM FLOW RATIO	OUTSIDE AIR FLOW	COOLING CAPACITY (KBTU/HR)	SENSIBLE (SHR)	EXTRACTION RATE (KBTU/HR)	HEATING CAPACITY (KBTU/HR)	ADDITION RATE (KBTU/HR)	MULTIPLIER
DAYROOM	2884.	0.	0.196	1.000	0.	153.20	0.66	80.93	-250.12	-250.75	1.0
1ROOM-S	2266.	0.	0.154	1.000	0.	114.96	0.69	63.58	-196.52	-197.02	1.0
1ROOM-N	2266.	0.	0.154	1.000	0.	121.04	0.65	63.58	-196.52	-197.02	1.0
2ROOM-S	2266.	0.	0.154	1.000	0.	119.09	0.66	63.58	-196.52	-197.02	1.0
2ROOM-N	2266.	0.	0.154	1.000	0.	125.78	0.63	63.59	-196.52	-197.02	1.0
3ROOM-S	2266.	0.	0.154	1.000	0.	119.09	0.66	63.58	-196.52	-197.02	1.0
3ROOM-N	2266.	0.	0.154	1.000	0.	120.84	0.65	63.58	-196.52	-197.02	1.0

FORT BRAGG HAMMERHEAD BARRACK ECO : TEMP SETBACK/REDUCED OA DOE-2.1C 10/19/1995 14:20:40 SDL RUN 1
GREEN
REP SS-D PLANT MONTHLY LOADS SUMMARY FOR DEFAULT-PLANT WEATHER FILE- TMY NASHVILLE, TN

	- - - C O O L I N G - - -						- - - H E A T I N G - - -						- - - E L E C - - -	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	0.00000					0.000	-171.079	12	18	16.F	13.F	-936.877	4210.	13.745
FEB	0.00000					0.000	-134.227	19	18	26.F	21.F	-760.560	3739.	13.745
MAR	0.00000					0.000	-98.426	21	18	39.F	36.F	-613.720	4103.	13.745
APR	8.75262	29	18	80.F	62.F	351.008	0.000					0.000	4080.	13.745
MAY	42.74890	16	18	86.F	71.F	500.116	0.000					0.000	4166.	13.745
JUN	94.61826	30	18	92.F	74.F	584.601	0.000					0.000	3945.	13.745
JUL	137.95361	23	19	90.F	77.F	604.782	0.000					0.000	4166.	13.745
AUG	120.53949	9	18	90.F	76.F	593.468	0.000					0.000	4166.	13.745
SEP	72.79940	5	18	89.F	75.F	563.883	0.000					0.000	3945.	13.745
OCT	0.00000					0.000	-41.521	28	6	35.F	32.F	-307.813	4166.	13.745
NOV	0.00000					0.000	-90.124	2	18	31.F	29.F	-800.923	3891.	13.745
DEC	0.00000					0.000	-170.748	23	18	26.F	24.F	-849.887	4155.	13.745
TOTAL	477.413						-706.126						48734.	
MAX						604.782						-936.877		13.745

FORT BRAGG HAMMERHEAD BARRACK ECO : TEMP SETBACK/REDUCED OA DOE-2.1C 10/19/1995 14:20:40 SDL RUN 1
GREEN
REP[illegible] SS-M FAN ELECTRIC ENERGY FOR PLANT DEFAULT-PLANT WEATHER FILE- TMY NASHVILLE, TN

MONTH	FAN ELECTRIC ENERGY DURING HEATING (KWH)	FAN ELECTRIC ENERGY DURING COOLING (KWH)	FAN ELECTRIC ENERGY DURING HEATING-COOLING (KWH)	FAN ELECTRIC ENERGY DURING FLOATING (KWH)
JAN	564.478	0.000	0.000	0.000
FEB	501.759	0.000	0.000	3.360
MAR	521.918	0.000	0.000	3.360
APR	0.000	185.920	0.000	318.079
MAY	0.000	376.319	0.000	144.480
JUN	0.000	496.159	0.000	7.840
JUL	0.000	518.558	0.000	2.240
AUG	0.000	520.798	0.000	0.000
SEP	0.000	474.879	0.000	29.120
[illegible]	517.438	0.000	0.000	3.360
NOV	518.558	0.000	0.000	0.000
DEC	576.798	0.000	0.000	0.000
ANNUAL	3201.073	2572.687	0.000	511.838

FORT BRAGG HAMMERHEAD BARRACK ECO : TEMP SETBACK/REDUCED OA DOE-2.1C 10/19/1995 14:20:40 SDL RUN 1
GREEN
REPORT- SS-A SYSTEM MONTHLY LOADS SUMMARY FOR FANCOIL WEATHER FILE- TMY NASHVILLE, TN

	- - - - - - - - - C O O L I N G - - - - - - - - -						- - - - - - - - - H E A T I N G - - - - - - - - -						- - - E L E C - - -	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	0.00000					0.000	-171.079	12	18	16.F	13.F	-936.877	4210.	13.745
FEB	0.00000					0.000	-134.227	19	18	26.F	21.F	-760.560	3739.	13.745
MAR	0.00000					0.000	-98.426	21	18	39.F	36.F	-613.720	4103.	13.745
APR	8.75262	29	18	80.F	62.F	351.008	0.000					0.000	4080.	13.745
MAY	42.74890	16	18	86.F	71.F	500.116	0.000					0.000	4166.	13.745
JUN	94.61826	30	18	92.F	74.F	584.601	0.000					0.000	3945.	13.745
JUL	137.95361	23	19	90.F	77.F	604.782	0.000					0.000	4166.	13.745
AUG	120.53949	9	18	90.F	76.F	593.468	0.000					0.000	4166.	13.745
SEP	72.79940	5	18	89.F	75.F	563.883	0.000					0.000	3945.	13.745
OCT	0.00000					0.000	-41.521	28	6	35.F	32.F	-307.813	4166.	13.745
NOV	0.00000					0.000	-90.124	2	18	31.F	29.F	-800.923	3891.	13.745
DEC	0.00000					0.000	-170.748	23	18	26.F	24.F	-849.887	4155.	13.745
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TOTAL	477.413						-706.126						48734.	
MAX						604.782						-936.877		13.745

FORT BRAGG HAMMERHEAD BARRACK ECO : TEMP SETBACK/REDUCED OA DOE-2.1C 10/19/1995 14:20:40 SDL RUN 1
GREEN
REF SS-B SYSTEM MONTHLY LOADS SUMMARY FOR FANCOIL WEATHER FILE- TMY NASHVILLE, TN

	- -Z O N E C O O L I N G- -		- -Z O N E H E A T I N G -		- - B A S E B O A R D S - -		- - - -P R E - H E A T - - -	
MONTH	ZONE COIL COOLING ENERGY (MBTU)	MAXIMUM ZONE COIL COOLING LOAD (KBTU/HR)	ZONE COIL HEATING ENERGY (MBTU)	MAXIMUM ZONE COIL HEATING LOAD (KBTU/HR)	BASEBOARD HEATING ENERGY (MBTU)	MAXIMUM BASEBOARD HEATING LOAD (KBTU/HR)	PRE-HEAT COIL ENERGY (MBTU)	MAXIMUM PRE-HEAT COIL LOAD (KBTU/HR)
JAN	0.00000	0.000	-171.07880	-936.877	0.00000	0.000	0.00000	0.000
FEB	0.00000	0.000	-134.22659	-760.560	0.00000	0.000	0.00000	0.000
MAR	0.00000	0.000	-98.42645	-613.720	0.00000	0.000	0.00000	0.000
APR	8.75262	351.008	0.00000	0.000	0.00000	0.000	0.00000	0.000
MAY	42.74890	500.116	0.00000	0.000	0.00000	0.000	0.00000	0.000
JUN	94.61826	584.601	0.00000	0.000	0.00000	0.000	0.00000	0.000
JUL	137.95361	604.782	0.00000	0.000	0.00000	0.000	0.00000	0.000
AUG	120.53949	593.468	0.00000	0.000	0.00000	0.000	0.00000	0.000
SEP	72.79940	563.883	0.00000	0.000	0.00000	0.000	0.00000	0.000
OCT	0.00000	0.000	-41.52140	-307.813	0.00000	0.000	0.00000	0.000
NOV	0.00000	0.000	-90.12445	-800.923	0.00000	0.000	0.00000	0.000
DEC	0.00000	0.000	-170.74829	-849.887	0.00000	0.000	0.00000	0.000
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TOTAL	477.413		-706.126		0.000		0.000	
MAX		604.782		-936.877		0.000		0.000

FORT BRAGG HAMMERHEAD BARRACK ECO : TEMP SETBACK/REDUCED OA DOE-2.1C 10/19/1995 14:20:40 SDL RUN 1
GREEN
REPORT- SS-H SYSTEM MONTHLY LOADS SUMMARY FOR FANCOIL WEATHER FILE- TMY NASHVILLE, TN

	----FAN ELEC----		---FUEL HEAT----		--ELEC HEAT----		---ELEC COOL---	
MONTH	FAN ELECTRIC ENERGY (KWH)	MAXIMUM FAN ELECTRIC LOAD (KW)	GAS OIL HEATING ENERGY (MBTU)	MAXIMUM GAS OIL HEATING LOAD (KBTU/HR)	ELECTRIC HEATING ENERGY (KWH)	MAXIMUM ELECTRIC HEATING LOAD (KW)	ELECTRIC COOLING ENERGY (KWH)	MAXIMUM ELECTRIC COOLING LOAD (KW)
JAN	564.	1.120	0.00000	0.000	0.	0.000	0.	0.000
FEB	505.	1.120	0.00000	0.000	0.	0.000	0.	0.000
MAR	525.	1.120	0.00000	0.000	0.	0.000	0.	0.000
APR	504.	1.120	0.00000	0.000	0.	0.000	0.	0.000
MAY	521.	1.120	0.00000	0.000	0.	0.000	0.	0.000
JUN	504.	1.120	0.00000	0.000	0.	0.000	0.	0.000
JUL	521.	1.120	0.00000	0.000	0.	0.000	0.	0.000
AUG	521.	1.120	0.00000	0.000	0.	0.000	0.	0.000
SEP	504.	1.120	0.00000	0.000	0.	0.000	0.	0.000
OCT	521.	1.120	0.00000	0.000	0.	0.000	0.	0.000
NOV	519.	1.120	0.00000	0.000	0.	0.000	0.	0.000
DEC	577.	1.120	0.00000	0.000	0.	0.000	0.	0.000
TOTAL	6286.		0.000		0.		0.	
MAX		1.120		0.000		0.000		0.000

FORT BRAGG HAMMERHEAD BARRACK   ECO : TEMP SETBACK/REDUCED OA   DOE-2.1C 10/19/1995 14:20:40 SDL RUN 1
GREEN
REP - SS-I SYSTEM MONTHLY SOURCE-LATENT SUMMARY FOR FANCOIL   WEATHER FILE- TMY NASHVILLE, TN

MONTH	SENSIBLE COOLING ENERGY (MBTU)	LATENT COOLING ENERGY (MBTU)	MAX TOTAL COOLING ENERGY (KBTU/HR)	SENSIBLE HEAT RATIO AT MAX	TIME OF MAX DY	HR	SENSIBLE HEATING ENERGY (MBTU)	LATENT HEATING ENERGY (MBTU)	MAX TOTAL HEATING ENERGY (KBTU/HR)
JAN	0.00000	0.00000	0.000				-171.07880	0.00000	-936.87744
FEB	0.00000	0.00000	0.000				-134.22659	0.00000	-760.56018
MAR	0.00000	0.00000	0.000				-98.42645	0.00000	-613.71967
APR	8.35085	0.40177	351.008	0.844	29	18	0.00000	0.00000	0.000
MAY	39.01949	3.72941	500.116	0.837	16	18	0.00000	0.00000	0.000
JUN	80.35703	14.26123	584.601	0.809	30	18	0.00000	0.00000	0.000
JUL	106.97470	30.97891	604.782	0.738	23	19	0.00000	0.00000	0.000
AUG	95.52886	25.01062	593.468	0.747	9	18	0.00000	0.00000	0.000
SEP	61.59065	11.20875	563.883	0.773	5	18	0.00000	0.00000	0.000
OCT	0.00000	0.00000	0.000				-41.52140	0.00000	-307.81277
NOV	0.00000	0.00000	0.000				-90.12445	0.00000	-800.92310
DEC	0.00000	0.00000	0.000				-170.74829	0.00000	-849.88721
TOTAL	391.822	85.591					-706.126	0.000	
MAX			604.782	0.738					-936.877

FORT BRAGG HAMMERHEAD BARRACK ECO : TEMP SETBACK/REDUCED OA DOE-2.1C 10/19/1995 14:20:40 SDL RUN 1
GREEN
RE[illegible]- SS-J SYSTEM PEAK HEATING AND COOLING DAYS FOR FANCOIL WEATHER FILE- TMY NASHVILLE, TN

	- - - - - C O O L I N G - - - - -				- - - H E A T I N G - - -		
	JUL 23				JAN 12		
HOUR	HOURLY COOLING LOAD (KBTU)	SENSIBLE HEAT RATIO	DRY-BULB TEMP	WET-BULB TEMP	HOURLY HEATING LOAD (KBTU)	DRY-BULB TEMP	WET-BULB TEMP
1	295.765	0.731	70.F	70.F	-636.596	20.F	18.F
2	256.262	0.761	70.F	69.F	-618.992	19.F	17.F
3	219.280	0.784	69.F	68.F	-686.028	18.F	16.F
4	206.461	0.753	69.F	69.F	-689.754	16.F	14.F
5	188.487	0.769	70.F	69.F	-655.366	15.F	13.F
6	190.677	0.767	70.F	69.F	-704.160	15.F	13.F
7	0.000	0.000	75.F	72.F	-670.851	14.F	12.F
8	0.000	0.000	79.F	74.F	0.000	14.F	12.F
9	0.000	0.000	84.F	76.F	-116.408	15.F	13.F
10	0.000	0.000	86.F	76.F	0.000	17.F	14.F
11	0.000	0.000	88.F	77.F	-153.723	18.F	15.F
12	0.000	0.000	90.F	77.F	0.000	19.F	16.F
[illegible]	0.000	0.000	91.F	77.F	-176.170	21.F	18.F
[illegible]	0.000	0.000	91.F	77.F	0.000	21.F	17.F
15	0.000	0.000	92.F	77.F	-194.979	21.F	17.F
16	72.810	0.989	91.F	77.F	0.000	19.F	16.F
17	601.209	0.773	91.F	77.F	-406.146	16.F	13.F
18	604.782	0.754	90.F	77.F	-936.877	16.F	13.F
19	576.450	0.733	87.F	77.F	-788.628	14.F	12.F
20	556.107	0.720	85.F	77.F	-789.417	14.F	12.F
21	519.916	0.716	82.F	76.F	-768.165	12.F	10.F
22	485.389	0.717	80.F	75.F	-755.940	12.F	10.F
23	464.988	0.707	79.F	75.F	-713.374	12.F	10.F
24	409.579	0.707	77.F	74.F	-709.541	11.F	9.F
	--------				--------		
MAX	604.782				-936.877		

FORT BRAGG HAMMERHEAD BARRACK ECO : TEMP SETBACK/REDUCED OA DOE-2.1C 10/19/1995 14:20:40 SDL RUN 1
GREEN
REPORT- SS-K SPACE TEMPERATURE SUMMARY FANCOIL WEATHER FILE- TMY NASHVILLE, TN

MONTH	AVERAGE SPACE TEMP ALL HOURS (F)	COOLING HOURS (F)	HEATING HOURS (F)	FAN ON HOURS (F)	FAN OFF HOURS (F)	AVERAGE TEMPERATURE DIFFERENCE BETWEEN OUTDOOR& ROOM AIR ALL HOURS (F)	BETWEEN OUTDOOR& ROOM AIR FAN ON HOURS (F)	BETWEEN OUTDOOR& ROOM AIR FAN OFF HOURS (F)	SUMMED TEMP DIFFERENCE BETWEEN OUTDOOR& ROOM AIR HEATING HOURS (F)	BETWEEN OUTDOOR& ROOM AIR ALL HOURS (F)	HUMIDITY RATIO DIFFERENCE BETWEEN OUTDOOR AND ROOM AIR (PERCENT-RH)
JAN	65.13		66.60	66.60	62.05	-24.98	-28.46	-17.68	597.74	774.52	0.00148
FEB	65.73		66.95	66.96	63.21	-23.51	-27.21	-15.98	511.50	660.00	0.00159
MAR	66.69		67.87	67.87	64.67	-17.42	-20.99	-11.34	410.33	544.23	0.00204
APR	66.57	70.43		66.63	66.49	-8.10	-11.64	-2.19		292.74	0.00271
MAY	71.32	71.86		71.07	71.74	-3.73	-5.66	-0.51		225.56	0.00422
JUN	73.44	72.43		72.42	75.16	1.69	-0.16	4.77		167.74	0.00637
JUL	74.06	72.76		72.78	76.21	4.19	3.13	5.96		172.34	0.00890
AUG	73.74	72.62		72.62	75.63	3.14	1.65	5.64		159.80	0.00786
SEP	72.78	72.18		72.11	73.91	-1.40	-2.98	1.24		186.06	0.00578
OCT	72.93		73.55	73.56	71.89	-12.63	-15.87	-7.24	308.39	404.36	0.00316
NOV	67.32		68.14	68.14	65.83	-16.62	-20.17	-10.22	389.06	501.20	0.00220
DEC	65.27		66.53	66.53	62.45	-24.76	-28.12	-17.21	603.37	767.56	0.00141
ANNUAL	69.61	72.26	68.22	69.72	69.41	-10.28	-13.31	-4.88	2820.39	4856.12	0.00399

FORT BRAGG HAMMERHEAD BARRACK   ECO : TEMP SETBACK/REDUCED OA   DOE-2.1C 10/19/1995   14:20:40 SDL RUN 1
GREEN
RE[illegible] - SS-L FAN ELECTRIC ENERGY   FANCOIL   WEATHER FILE- TMY NASHVILLE, TN

MONTH	FAN ELECTRIC ENERGY DURING HEATING (KWH)	FAN ELECTRIC ENERGY DURING COOLING (KWH)	FAN ELECTRIC ENERGY DURING HEATING-COOLING (KWH)	FAN ELECTRIC ENERGY DURING FLOATING (KWH)
JAN	564.478	0.000	0.000	0.000
FEB	501.759	0.000	0.000	3.360
MAR	521.918	0.000	0.000	3.360
APR	0.000	185.920	0.000	318.079
MAY	0.000	376.319	0.000	144.480
JUN	0.000	496.159	0.000	7.840
JUL	0.000	518.558	0.000	2.240
AUG	0.000	520.798	0.000	0.000
[illegible]	0.000	474.879	0.000	29.120
OCT	517.438	0.000	0.000	3.360
NOV	518.558	0.000	0.000	0.000
DEC	576.798	0.000	0.000	0.000
ANNUAL	3201.073	2572.687	0.000	511.838

FORT BRAGG HAMMERHEAD BARRACK ECO : TEMP SETBACK/REDUCED OA DOE-2.1C 10/19/1995 14:20:40 SDL RUN 1
GREEN

RE[illegible] - SS-F ZONE DEMAND SUMMARY IN FANCOIL FOR DAYROOM WEATHER FILE- TMY NASHVILLE, TN

	- - - -DEMANDS- - - - -		- -BASEBOARDS- - -		- -TEMPERATURES- -		- -LOADS NOT MET- -	
MONTH	HEAT EXTRACTION ENERGY (MBTU)	HEAT ADDITION ENERGY (MBTU)	BASEBOARD ENERGY (MBTU)	MAXIMUM BASEBOARD LOAD (KBTU/HR)	MAXIMUM ZONE TEMP (F)	MINIMUM ZONE TEMP (F)	HOURS UNDER HEATED	HOURS UNDER COOLED
JAN	0.00174	-5.089	0.00000	0.000	69.7	60.9	0	0
FEB	0.00253	-3.551	0.00000	0.000	72.5	62.5	0	0
MAR	0.00092	-2.354	0.00000	0.000	71.9	62.8	0	0
APR	0.94429	-0.238	0.00000	0.000	75.9	60.8	0	0
MAY	2.95354	-0.069	0.00000	0.000	76.6	68.9	0	0
JUN	4.91162	-0.007	0.00000	0.000	77.7	71.0	0	0
JUL	6.12249	-0.004	0.00000	0.000	77.3	71.1	0	0
AUG	5.98937	-0.005	0.00000	0.000	77.7	71.1	0	0
SEP	4.80460	-0.006	0.00000	0.000	77.5	70.9	0	0
OCT	0.00000	-0.380	0.00000	0.000	88.7	68.2	0	0
NOV	0.00007	-1.974	0.00000	0.000	73.7	61.2	0	0
DEC	0.00023	-5.102	0.00000	0.000	70.1	60.4	0	0

FORT BRAGG HAMMERHEAD BARRACK ECO : TEMP SETBACK/REDUCED OA DOE-2.1C 10/19/1995 14:20:40 SDL RUN 1
GREEN
REP - SS-F ZONE DEMAND SUMMARY IN FANCOIL FOR 1ROOM-S WEATHER FILE- TMY NASHVILLE, TN

	- - - -D E M A N D S- - - - -		- -B A S E B O A R D S- - -		- -T E M P E R A T U R E S- -		- -L O A D S N O T M E T- -	
MONTH	HEAT EXTRACTION ENERGY (MBTU)	HEAT ADDITION ENERGY (MBTU)	BASEBOARD ENERGY (MBTU)	MAXIMUM BASEBOARD LOAD (KBTU/HR)	MAXIMUM ZONE TEMP (F)	MINIMUM ZONE TEMP (F)	HOURS UNDER HEATED	HOURS UNDER COOLED
JAN	0.00164	-8.450	0.00000	0.000	69.4	57.9	0	0
FEB	0.00233	-5.959	0.00000	0.000	72.8	58.0	0	0
MAR	0.00133	-3.575	0.00000	0.000	73.0	60.2	0	0
APR	1.90454	-0.190	0.00000	0.000	77.9	57.7	0	0
MAY	5.55725	-0.059	0.00000	0.000	79.7	67.0	0	0
JUN	9.46040	-0.001	0.00000	0.000	81.0	71.1	0	0
JUL	11.79796	0.000	0.00000	0.000	81.0	71.2	0	0
AUG	11.62929	0.000	0.00000	0.000	81.2	71.4	0	0
SEP	9.31868	-0.001	0.00000	0.000	81.2	71.1	0	0
OCT	0.00400	-0.431	0.00000	0.000	89.0	67.9	0	0
NOV	0.00071	-3.256	0.00000	0.000	74.7	58.0	0	0
DEC	0.00112	-8.511	0.00000	0.000	70.3	57.9	0	0

FORT BRAGG HAMMERHEAD BARRACK ECO : TEMP SETBACK/REDUCED OA DOE-2.1C 10/19/1995 14:20:40 SDL RUN 1
GREEN
RE SS-F ZONE DEMAND SUMMARY IN FANCOIL FOR 1ROOM-N WEATHER FILE- TMY NASHVILLE, TN

	- - - -DEMANDS- - - - -		- -BASEBOARDS- - -		- -TEMPERATURES- -		- -LOADS NOT MET- -	
MONTH	HEAT EXTRACTION ENERGY (MBTU)	HEAT ADDITION ENERGY (MBTU)	BASEBOARD ENERGY (MBTU)	MAXIMUM BASEBOARD LOAD (KBTU/HR)	MAXIMUM ZONE TEMP (F)	MINIMUM ZONE TEMP (F)	HOURS UNDER HEATED	HOURS UNDER COOLED
JAN	0.00008	-10.915	0.00000	0.000	68.0	57.7	0	0
FEB	0.00031	-8.258	0.00000	0.000	69.3	57.9	0	0
MAR	0.00099	-5.612	0.00000	0.000	71.5	59.2	0	0
APR	0.91035	-0.199	0.00000	0.000	76.0	54.8	0	0
MAY	4.45720	-0.066	0.00000	0.000	78.6	65.3	0	0
JUN	8.71055	-0.001	0.00000	0.000	80.8	71.1	0	0
JUL	10.67359	0.000	0.00000	0.000	80.8	71.2	0	0
AU	9.31364	-0.001	0.00000	0.000	79.8	71.2	0	0
SEP	5.87749	-0.006	0.00000	0.000	78.4	70.4	0	0
OCT	0.00267	-1.471	0.00000	0.000	82.3	64.0	0	0
NOV	0.00043	-5.256	0.00000	0.000	71.1	57.9	0	0
DEC	0.00000	-10.972	0.00000	0.000	69.1	57.9	0	0

FORT BRAGG HAMMERHEAD BARRACK　　ECO : TEMP SETBACK/REDUCED OA　　DOE-2.1C 10/19/1995 14:20:40 SDL RUN 1
GREEN
REPORT- SS-F ZONE DEMAND SUMMARY IN FANCOIL FOR 2ROOM-S　　WEATHER FILE- TMY NASHVILLE, TN

	----DEMANDS-----		--BASEBOARDS---		--TEMPERATURES--		--LOADS NOT MET--	
MONTH	HEAT EXTRACTION ENERGY (MBTU)	HEAT ADDITION ENERGY (MBTU)	BASEBOARD ENERGY (MBTU)	MAXIMUM BASEBOARD LOAD (KBTU/HR)	MAXIMUM ZONE TEMP (F)	MINIMUM ZONE TEMP (F)	HOURS UNDER HEATED	HOURS UNDER COOLED
JAN	0.00034	-15.146	0.00000	0.000	68.6	57.8	0	0
FEB	0.00045	-10.885	0.00000	0.000	71.7	57.9	0	0
MAR	0.00002	-6.843	0.00000	0.000	72.4	59.3	0	0
APR	2.32252	-0.215	0.00000	0.000	77.7	56.3	0	0
MAY	7.40365	-0.077	0.00000	0.000	79.7	65.4	0	2
JUN	13.35342	-0.001	0.00000	0.000	81.0	71.1	0	12
JUL	16.95435	0.000	0.00000	0.000	81.1	71.3	0	20
AUG	16.54416	0.000	0.00000	0.000	81.4	71.5	0	21
SEP	12.92331	-0.002	0.00000	0.000	81.3	70.9	0	12
OCT	0.00198	-0.708	0.00000	0.000	88.1	67.0	0	0
NOV	0.00034	-5.981	0.00000	0.000	73.8	57.9	0	0
DEC	0.00035	-15.120	0.00000	0.000	69.6	57.8	0	0

FORT BRAGG HAMMERHEAD BARRACK   ECO : TEMP SETBACK/REDUCED OA   DOE-2.1C 10/19/1995   14:20:40 SDL RUN 1
GREEN
RE[illegible]- SS-F ZONE DEMAND SUMMARY IN   FANCOIL   FOR 2ROOM-N   WEATHER FILE- TMY NASHVILLE, TN

	----DEMANDS-----		--BASEBOARDS---		--TEMPERATURES--		--LOADS NOT MET--	
MONTH	HEAT EXTRACTION ENERGY (MBTU)	HEAT ADDITION ENERGY (MBTU)	BASEBOARD ENERGY (MBTU)	MAXIMUM BASEBOARD LOAD (KBTU/HR)	MAXIMUM ZONE TEMP (F)	MINIMUM ZONE TEMP (F)	HOURS UNDER HEATED	HOURS UNDER COOLED
JAN	0.00000	-16.595	0.00000	0.000	67.9	57.5	0	0
FEB	0.00000	-12.675	0.00000	0.000	69.0	57.8	0	0
MAR	0.00014	-8.927	0.00000	0.000	71.0	58.7	0	0
APR	0.99634	-0.219	0.00000	0.000	75.8	53.5	0	0
MAY	5.41461	-0.079	0.00000	0.000	78.6	63.8	0	0
JUN	11.20608	-0.001	0.00000	0.000	81.0	71.1	0	2
JUL	13.91508	0.000	0.00000	0.000	81.0	71.3	0	11
A[illegible]	11.99373	-0.001	0.00000	0.000	80.0	71.3	0	2
SEP	7.21030	-0.018	0.00000	0.000	78.5	69.5	0	0
OCT	0.00117	-2.553	0.00000	0.000	81.6	63.3	0	0
NOV	0.00000	-8.299	0.00000	0.000	70.6	57.9	0	0
DEC	0.00002	-16.579	0.00000	0.000	68.6	57.8	0	0

FORT BRAGG HAMMERHEAD BARRACK ECO : TEMP SETBACK/REDUCED OA DOE-2.1C 10/19/1995 14:20:40 SDL RUN 1
GREEN
REPORT- SS-F ZONE DEMAND SUMMARY IN FANCOIL FOR 3ROOM-S WEATHER FILE- TMY NASHVILLE, TN

	- - - - D E M A N D S - - - - -		- - B A S E B O A R D S - - -		- - T E M P E R A T U R E S - -		- - L O A D S N O T M E T - -	
MONTH	HEAT EXTRACTION ENERGY (MBTU)	HEAT ADDITION ENERGY (MBTU)	BASEBOARD ENERGY (MBTU)	MAXIMUM BASEBOARD LOAD (KBTU/HR)	MAXIMUM ZONE TEMP (F)	MINIMUM ZONE TEMP (F)	HOURS UNDER HEATED	HOURS UNDER COOLED
JAN	0.00108	-35.779	0.00000	0.000	67.8	57.2	0	0
FEB	0.00113	-27.104	0.00000	0.000	70.0	57.4	0	0
MAR	0.00037	-19.073	0.00000	0.000	71.7	57.8	0	0
APR	1.95733	-0.291	0.00000	0.000	78.3	52.0	0	0
MAY	8.19561	-0.130	0.00000	0.000	81.0	60.3	0	4
JUN	16.63384	-0.010	0.00000	0.000	81.5	69.8	0	37
JUL	21.71590	-0.002	0.00000	0.000	81.5	70.7	0	82
AUG	19.93625	0.000	0.00000	0.000	81.7	71.1	0	58
SEP	13.89065	-0.032	0.00000	0.000	81.6	68.8	0	31
OCT	0.00431	-4.712	0.00000	0.000	86.1	64.3	0	0
NOV	0.00075	-16.886	0.00000	0.000	72.3	57.4	0	0
DEC	0.00057	-35.567	0.00000	0.000	68.0	57.3	0	0

FORT BRAGG HAMMERHEAD BARRACK ECO : TEMP SETBACK/REDUCED OA DOE-2.1C 10/19/1995 14:20:40 SDL RUN 1
GREEN
REPORT- SS-F ZONE DEMAND SUMMARY IN FANCOIL FOR 3ROOM-N WEATHER FILE- TMY NASHVILLE, TN

	----DEMANDS----		---BASEBOARDS---		--TEMPERATURES--		--LOADS NOT MET--	
MONTH	HEAT EXTRACTION ENERGY (MBTU)	HEAT ADDITION ENERGY (MBTU)	BASEBOARD ENERGY (MBTU)	MAXIMUM BASEBOARD LOAD (KBTU/HR)	MAXIMUM ZONE TEMP (F)	MINIMUM ZONE TEMP (F)	HOURS UNDER HEATED	HOURS UNDER COOLED
JAN	0.00000	-33.924	0.00000	0.000	67.8	57.0	0	0
FEB	0.00018	-26.728	0.00000	0.000	68.8	57.4	0	0
MAR	0.00083	-19.438	0.00000	0.000	70.7	57.7	0	0
APR	0.95129	-0.295	0.00000	0.000	76.7	50.0	0	0
MAY	6.24820	-0.133	0.00000	0.000	80.1	59.1	0	1
JUN	14.20030	-0.009	0.00000	0.000	81.4	69.8	0	14
JUL	18.48081	-0.002	0.00000	0.000	81.4	70.8	0	36
AUG	15.38447	-0.002	0.00000	0.000	81.2	70.8	0	10
SEP	8.76605	-0.054	0.00000	0.000	80.4	66.8	0	2
OCT	0.00377	-6.937	0.00000	0.000	81.1	60.9	0	0
NOV	0.00001	-18.238	0.00000	0.000	69.9	57.5	0	0
DEC	0.00000	-34.008	0.00000	0.000	68.0	57.3	0	0

FORT BRAGG HAMMERHEAD BARRACK ECO : TEMP SETBACK/REDUCED OA DOE-2.1C 10/19/1995 14:20:40 PDL RUN 1
GREEN
REPORT- PV-A EQUIPMENT SIZES WEATHER FILE- TMY NASHVILLE, TN

EQUIPMENT	SIZE (MBTU/)	NUMBER INSTD	NUMBER AVAIL	SIZE (MBTU/)	NUMBER INSTD	NUMBER AVAIL	SIZE (MBTU/)	NUMBER INSTD	NUMBER AVAIL	SIZE (MBTU/)	NUMBER INSTD	NUMBER AVAIL	SIZE (MBTU/)	NUMBER INSTD	NUMBER AVAIL	SIZE (MBTU/)	NUMBER INSTD	NUMBER AVAIL
DIESEL-GEN	0.057	1	1															

FORT BRAGG HAMMERHEAD BARRACK ECO : TEMP SETBACK/REDUCED OA DOE-2.1C 10/19/1995 14:20:40 PDL RUN 1
GREEN
REPORT- PS-A PLANT ENERGY UTILIZATION SUMMARY WEATHER FILE- TMY NASHVILLE, TN

	SITE ENERGY												SOURCE
	2	3	4	5	6	7	8	9	10	11	12	13	14
MONTH	TOTAL HEAT LOAD	TOTAL COOLING LOAD	TOTAL ELECTR LOAD	RCVRED ENERGY	WASTED RCVRABL ENERGY	HEAT INPUT COOLING	ELEC INPUT COOLING	FUEL INPUT HEATING	ELEC INPUT HEATING	FUEL INPUT ELECT	TOTAL FUEL INPUT	TOTAL SITE ENERGY	TOTAL SOURCE ENERGY
JAN	174.2	0.0	16.1 4.7E	0.0	0.0	0.0	0.0 0.0E	0.0	1.8 0.5E	0.0	0.0	190.4	338.8
FEB	137.0	0.0	14.3 4.2E	0.0	0.0	0.0	0.0 0.0E	0.0	1.6 0.5E	0.0	0.0	151.3	271.4
MAR	101.3	0.0	15.6 4.6E	0.0	0.0	0.0	0.0 0.0E	0.0	1.6 0.5E	0.0	0.0	117.0	215.8
APR	0.0	10.8	15.0 4.4E	0.0	0.0	0.0	1.1 0.3E	0.0	0.0 0.0E	0.0	0.0	25.8	52.4
MAY	0.0	46.8	16.5 4.8E	0.0	0.0	0.0	2.3 0.7E	0.0	0.0 0.0E	0.0	0.0	63.3	80.7
JUN	0.0	100.0	16.4 4.8E	0.0	0.0	0.0	3.0 0.9E	0.0	0.0 0.0E	0.0	0.0	116.4	116.1
JUL	0.0	143.6	17.3 5.1E	0.0	0.0	0.0	3.1 0.9E	0.0	0.0 0.0E	0.0	0.0	160.9	147.8
AUG	0.0	126.2	17.4 5.1E	0.0	0.0	0.0	3.1 0.9E	0.0	0.0 0.0E	0.0	0.0	143.5	136.2
SEP	0.0	77.9	16.3 4.8E	0.0	0.0	0.0	2.9 0.8E	0.0	0.0 0.0E	0.0	0.0	94.3	101.0
OCT	44.4	0.0	15.8 4.6E	0.0	0.0	0.0	0.0 0.0E	0.0	1.6 0.5E	0.0	0.0	60.2	121.5
NOV	93.0	0.0	14.9 4.4E	0.0	0.0	0.0	0.0 0.0E	0.0	1.6 0.5E	0.0	0.0	107.9	199.8
DEC	174.0	0.0	16.0 4.7E	0.0	0.0	0.0	0.0 0.0E	0.0	1.8 0.5E	0.0	0.0	189.9	337.9
	=======	=======	=======	=======	=======	=======	=======	=======	=======	=======	=======	=======	=======
	724.0	505.2	191.8 56.2E	0.0	0.0	0.0	15.5 4.5E	0.0	9.9 2.9E	0.0	0.0	1421.0	2119.3

NOTE-- ALL ENTRIES ARE IN MBTU EXCEPT
ENTRIES FOLLOWED BY E ARE IN MWH (THOUSANDS OF KWH)

FORT BRAGG HAMMERHEAD BARRACK ECO : TEMP SETBACK/REDUCED OA DOE-2.1C 10/19/1995 14:20:40 PDL RUN 1
GREEN
REPORT - PS-D PLANT LOADS SATISFIED WEATHER FILE- TMY NASHVILLE, TN

HEATING INPUTS	MBTU SUPPLIED	PCT OF TOTAL LOAD
STEAM	724.0	100.0
LOAD SATISFIED	724.0	100.0
TOTAL LOAD ON PLANT	724.0	

COOLING INPUTS	MBTU SUPPLIED	PCT OF TOTAL LOAD
CHILLED-WATER	505.2	100.0
LOAD SATISFIED	505.2	100.0
TOTAL LOAD ON PLANT	505.2	

ELECTRICAL INPUTS	MBTU SUPPLIED	PCT OF TOTAL LOAD
DIESEL-GEN	0.0	0.0
ELECTRICITY	191.8	100.0
LOAD SATISFIED	191.8	100.0
TOTAL LOAD ON PLANT	191.8	

SUMMARY OF LOADS MET

TYPE OF LOAD	TOTAL LOAD (MBTU)	LOAD SATISFIED (MBTU)	TOTAL OVERLOAD (MBTU)	PEAK OVERLOAD (MBTU)	HOURS OVERLOADED
HEATING INPUTS	724.0	724.0	0.000	0.000	0
COOLING INPUTS	505.2	505.2	0.000	0.000	0
ELECTRICAL INPUTS	191.8	191.8	0.000	0.000	0

FORT BRAGG HAMMERHEAD BARRACK ECO : TEMP SETBACK/REDUCED OA DOE-2.1C 10/19/1995 14:20:40 PDL RUN 1
GREEN
RE - BEPS ESTIMATED BUILDING ENERGY PERFORMANCE WEATHER FILE- TMY NASHVILLE, TN

ENERGY TYPE IN SITE MBTU -	STEAM	CHILLED-WATE	ELECTRICITY	DIESEL-OIL
CATEGORY OF USE				
SPACE HEAT	723.96	0.00	0.00	0.00
SPACE COOL	0.00	505.21	0.00	0.00
HVAC AUX	0.00	0.00	46.85	0.00
DOM HOT WTR	0.00	0.00	0.00	0.00
AUX SOLAR	0.00	0.00	0.00	0.00
LIGHTS	0.00	0.00	117.78	0.00
VERT TRANS	0.00	0.00	0.00	0.00
MISC EQUIP	0.00	0.00	27.15	0.00
TOTAL	723.96	505.21	191.78	0.00

TOTAL SITE ENERGY 1420.96 MBTU 68.4 KBTU/SQFT-YR GROSS-AREA 68.4 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY 2119.34 MBTU 102.0 KBTU/SQFT-YR GROSS-AREA 102.0 KBTU/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 3.8
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.0

NOTE ELECTRICITY AND/OR FUEL USED TO GENERATE ELECTRICITY IS APPORTIONED BASED
ON THE YEARLY DEMAND. ALL OTHER ENERGY TYPE

C

MATCH LINE SEE SHEET
SC-4 FOR CONTINUATION

MATCH LINE SEE SHEET
SC-3 FOR CONTINUATION

MATCH LINE SEE SHEET
SC-2 FOR CONTINUATION

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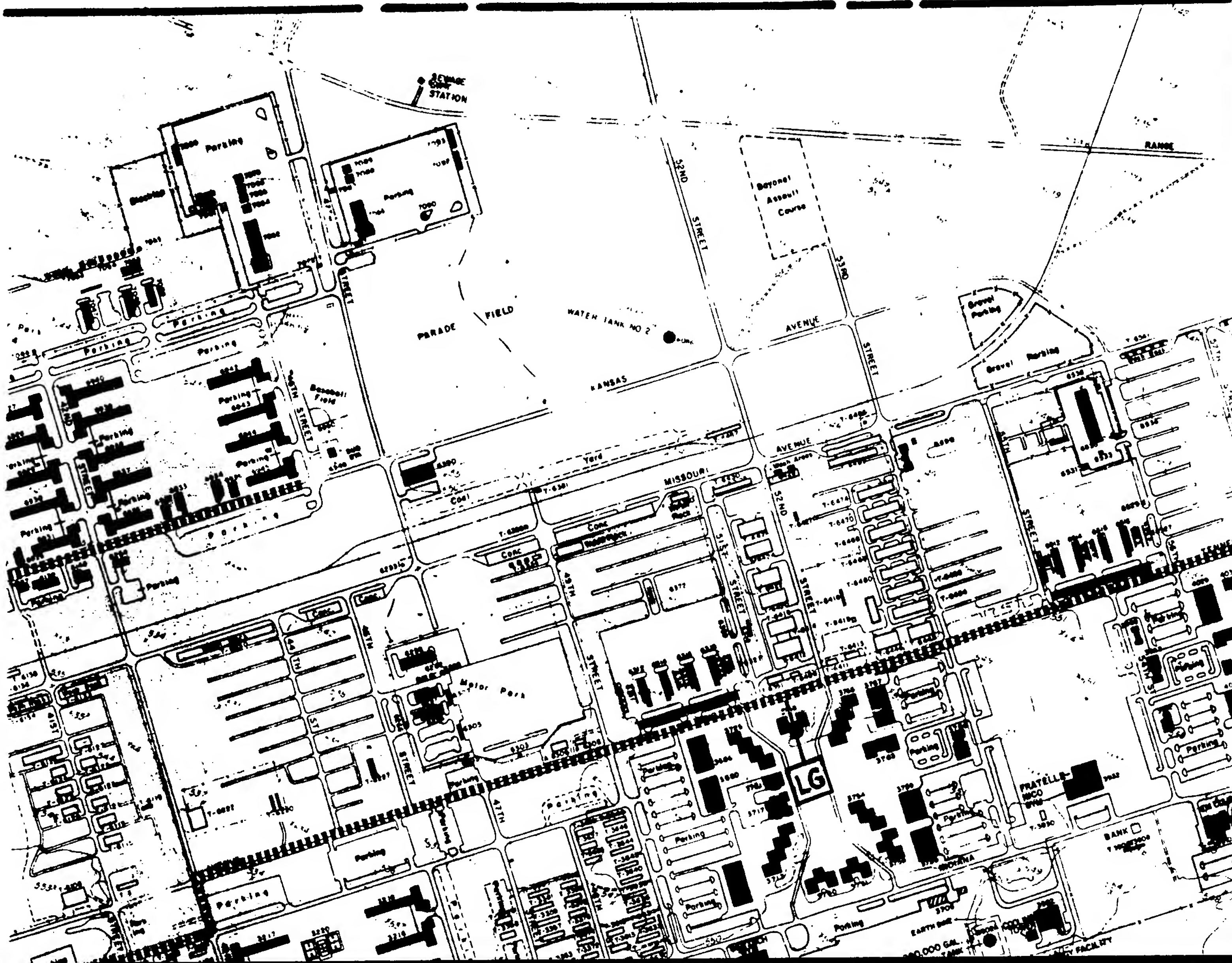
1

ΞE SHEET
TINUATION

2



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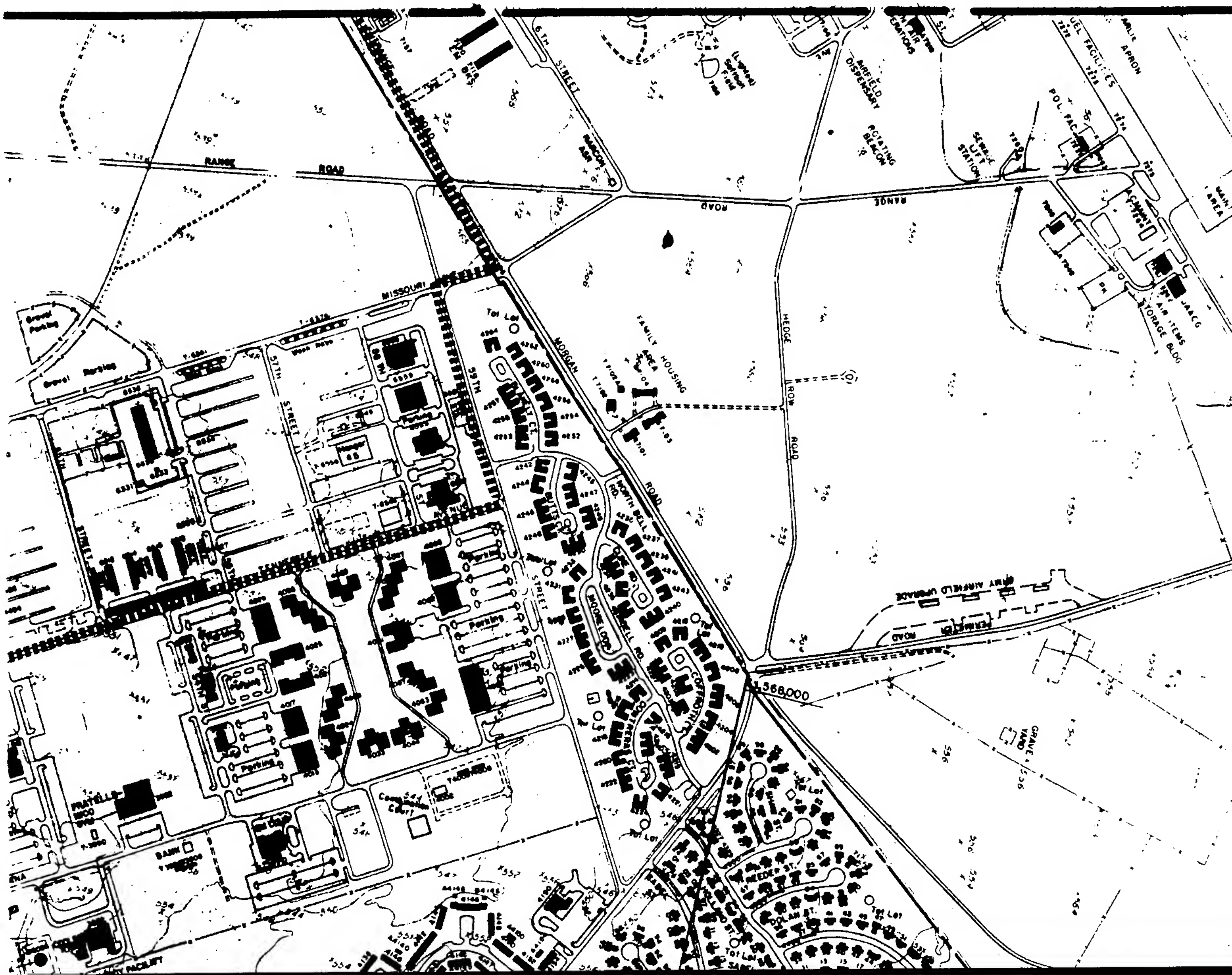
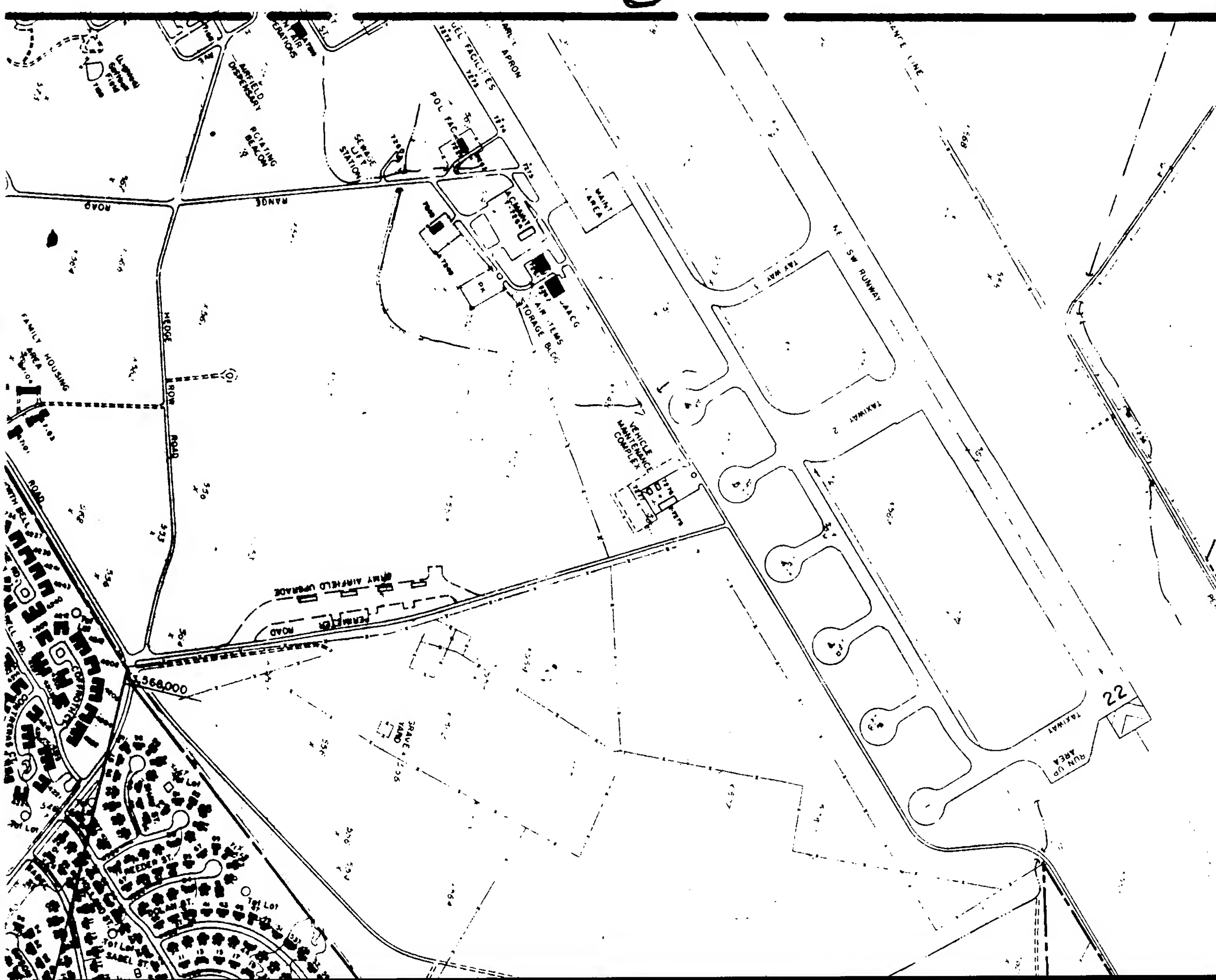
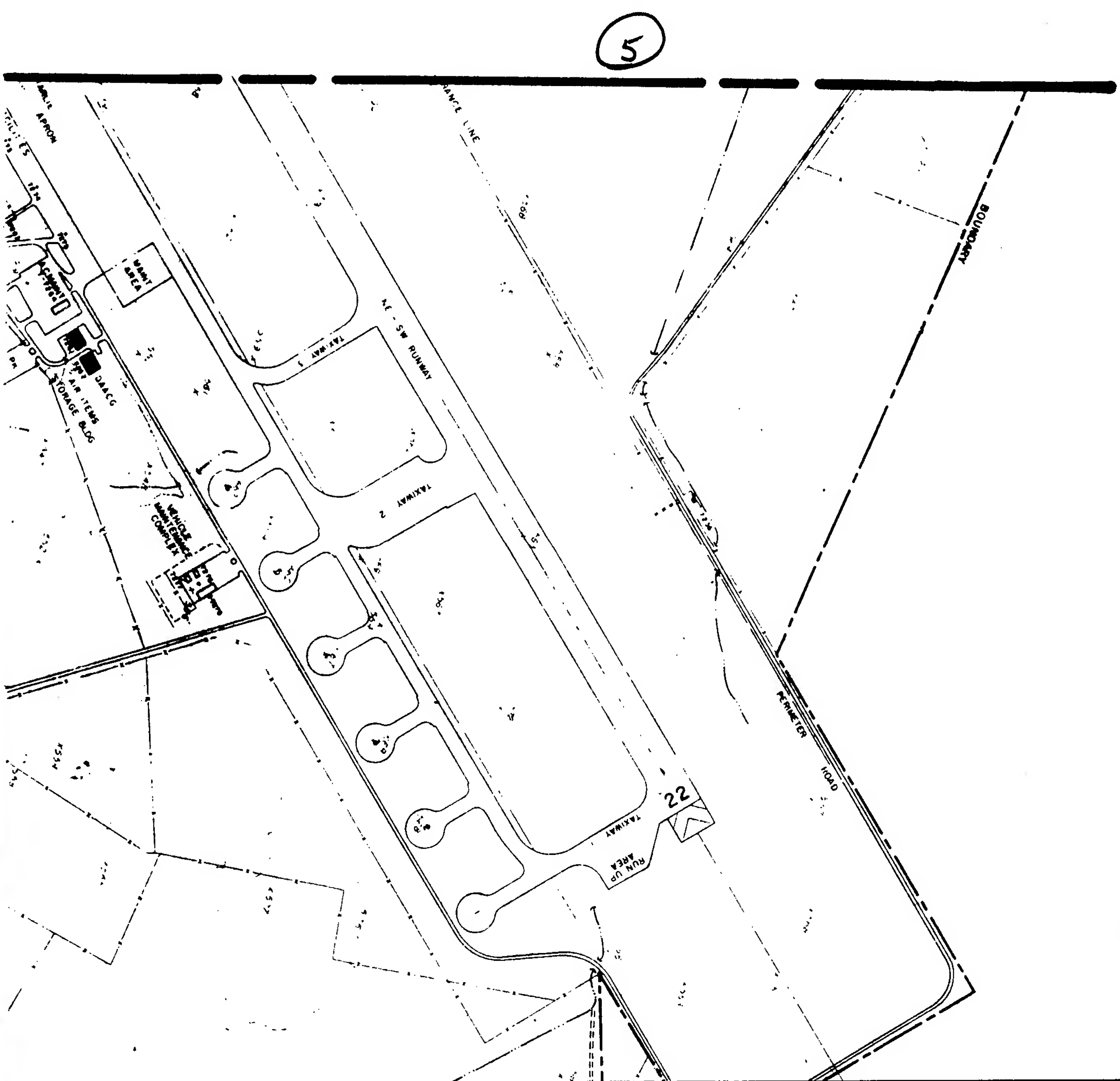


RANGE
ROAD
MISSOURI
MORGAN
ROAD
HEDGE ROW ROAD
FAMILY HOUSING AREA
ROTATING BEACON
AIRFIELD DISPENSARY
57TH STREET
59TH
STREET
568,000
GRAVE YARD
Parking
Tot Lot

4



NE - SW RUNWAY
TAXIWAY 2
TAXIWAY
VEHICLE MAINTENANCE COMPLEX
FAMILY HOUSING AREA
HEDGE ROW ROAD
RANGE ROAD
PERIMETER ROAD
ARMY AIRFIELD UPGRADE
STORAGE BLDG
SEWAGE LIFT STATION
ROTATING BEACON
AIRFIELD DISPENSARY
MAINT AREA
APRON
RUN UP AREA
22
568,000


5
APRON
NE - SW RUNWAY
TAXIWAY 1
TAXIWAY 2
TAXIWAY
RUN UP AREA
22
PERIMETER ROAD
BOUNDARY
VEHICLE MAINTENANCE COMPLEX
AIR ITEMS STORAGE BLDG
DAACG

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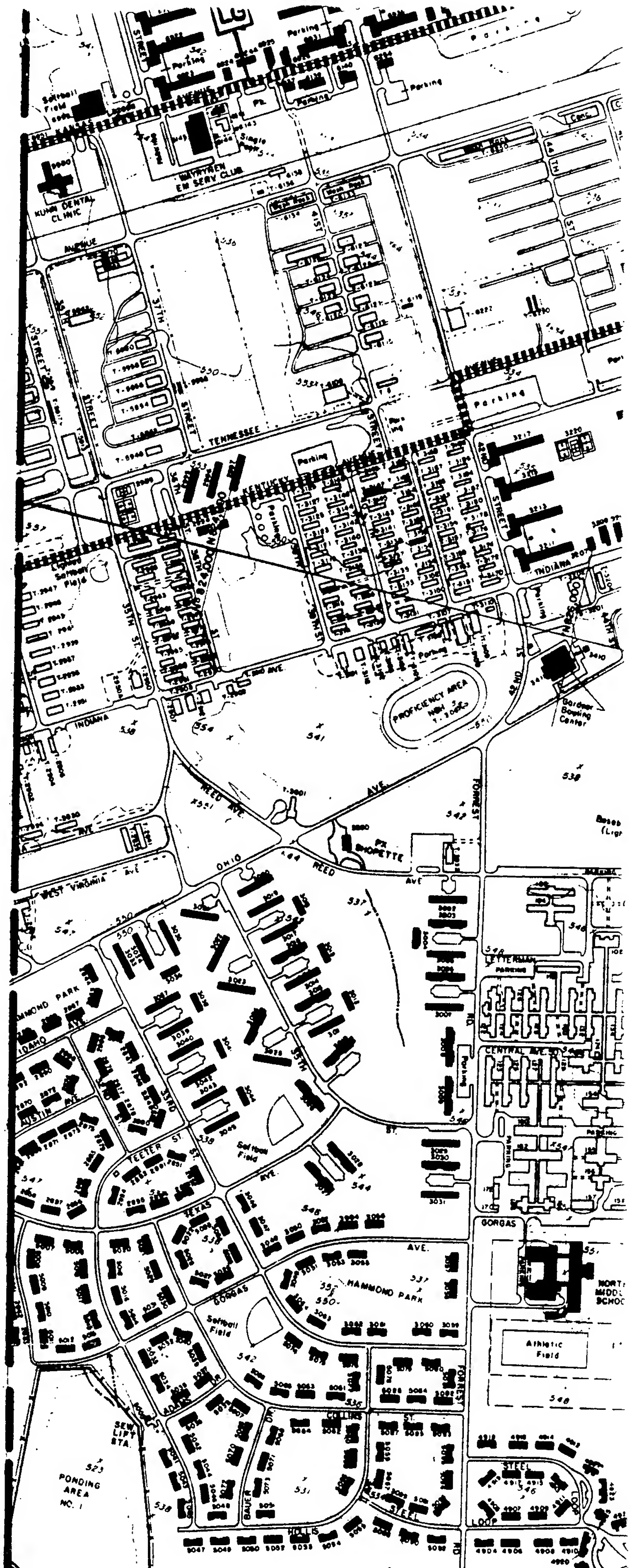

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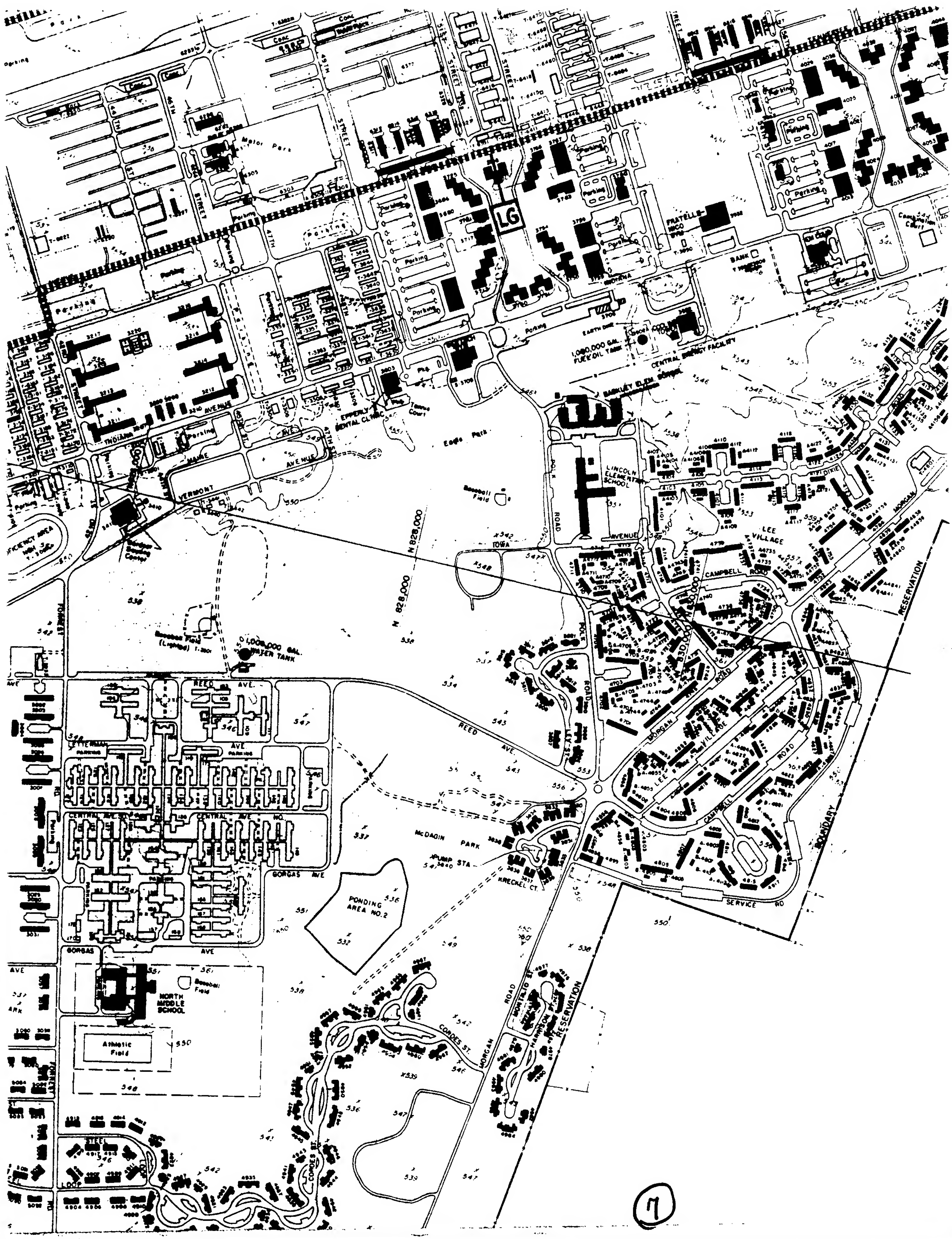
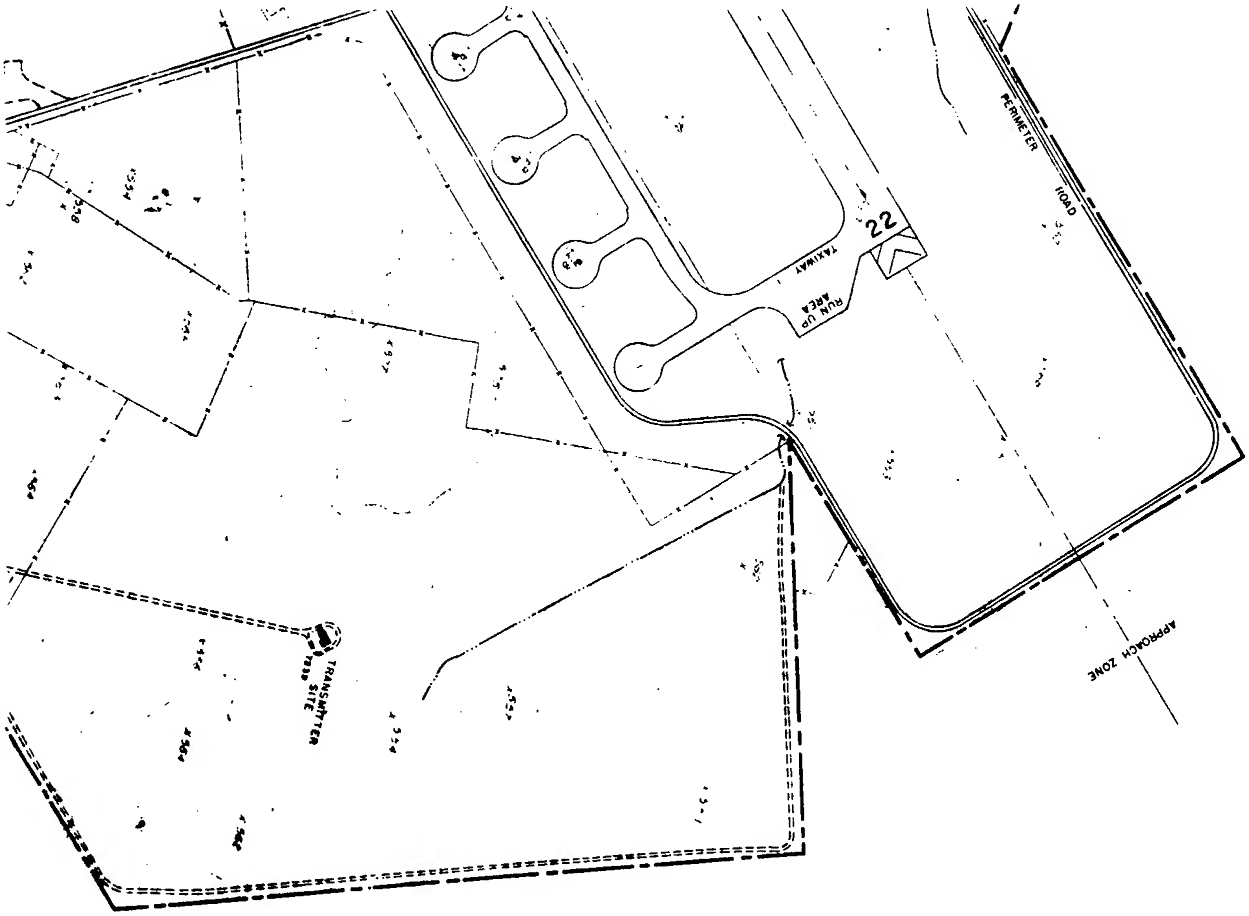


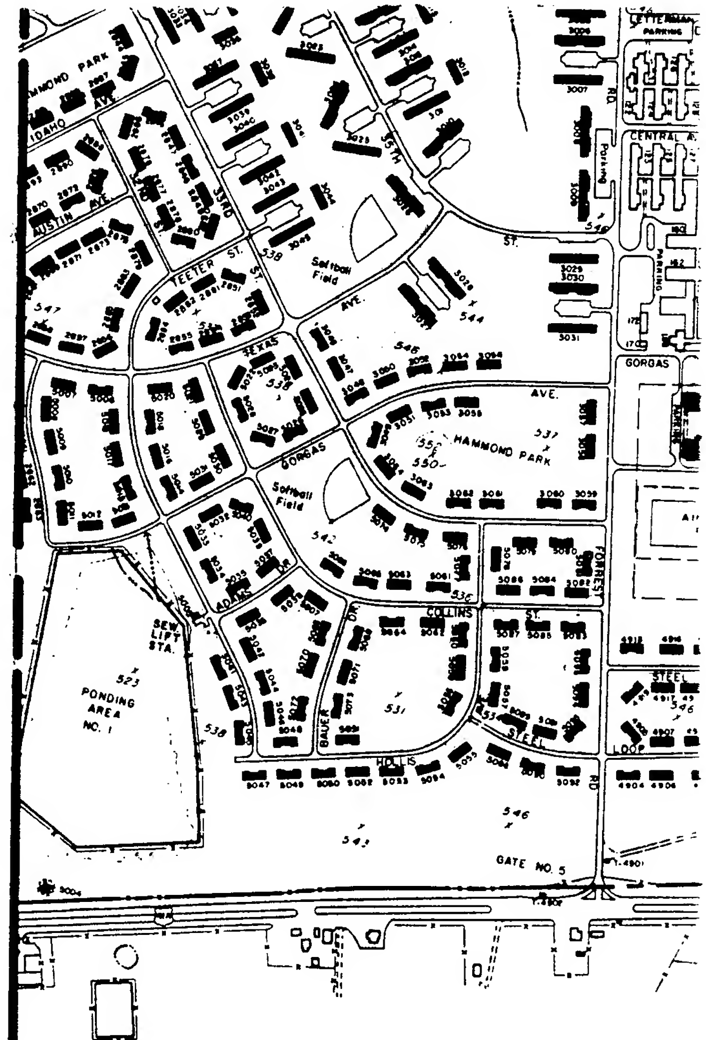
LG
Motor Park
Parking
INDIANA
AVENUE
VERMONT
Eagle Park
EPPERLY DENTAL CLINIC
1,080,000 GAL. FUEL OIL TANK
CENTRAL ENERGY FACILITY
LINCOLN ELEMENTARY SCHOOL
Baseball Field
IOWA
LEE VILLAGE
CAMPBELL ROAD
MORGAN
RESERVATION
BOUNDARY
1,000,000 GAL. WATER TANK
REED AVE.
LETTERMAN AVE.
CENTRAL AVE.
GORGAS AVE
PUMP STA.
KRECKEL CT.
PONDING AREA NO. 2
SERVICE RD
NORTH MIDDLE SCHOOL
Athletic Field
CORDES ST.
MORGAN ROAD

7


ARMY AIRFIELD UPGRADE
PERIMETER ROAD
568,000
GRAVE YARD
TRANSMITTER SITE
PIERCE VILLAGE
LITWIN ST.
SABEL ST.
DOLAN ST.
BEERS ST.
HOLLAND ST.
Tot Lot
Baseball Field
Basketball Court
Softball Field
Volleyball Court
Football Play Area
BOUNDARY
RESERVATION

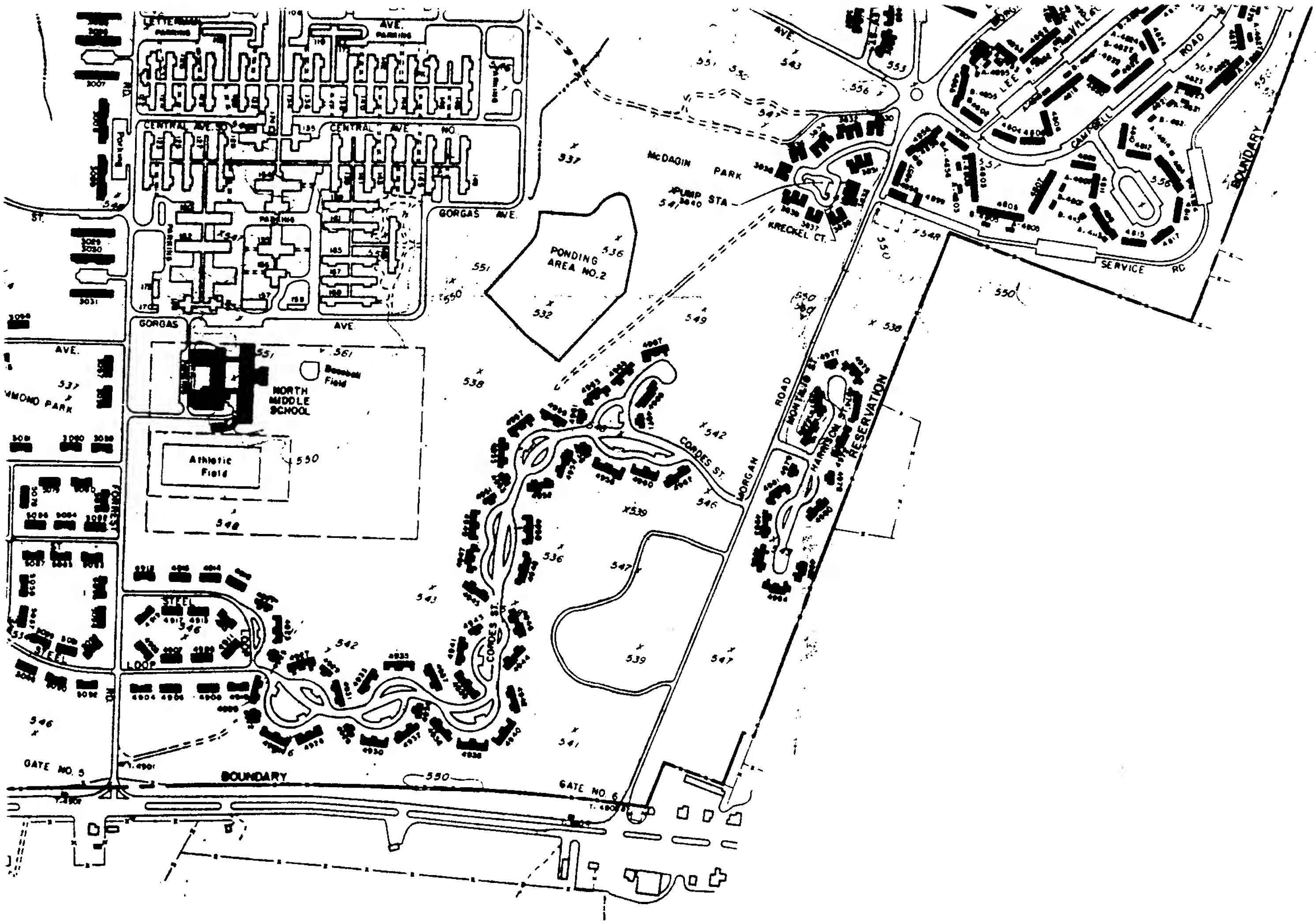

PERIMETER
ROAD
22
TAXIWAY
RUN UP
AREA
TRANSMITTER
SITE
APPROACH ZONE

10	DATE	D
	BY	


HAMMOND PARK
IDAHO
AVE.
AUSTIN AVE.
TEETER ST.
33RD
35TH
ST.
Softball Field
AVE.
TEXAS
GORGAS
HAMMOND PARK
Softball Field
ADAMS
DR.
COLLINS ST.
FORREST
BAUER
HOLLIS
STEEL
LOOP
RD.
SEW. LIFT STA.
PONDING AREA NO. 1
GATE NO. 5
LETTERMAN
CENTRAL AV
GORGAS
Parking

11

DATE	C
BY	



LEGEND

SYMBOL	DESCRIPTION
	FIBER OPTIC NETWORK
	WIRELESS COMMUNICATION
LG	LANGATE (NETWORK INTERFACE)
PC	COMPUTER MONITOR/ CONTROL STATIONS

SC-

SC-

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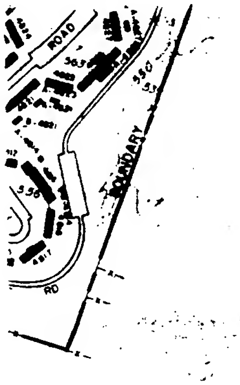
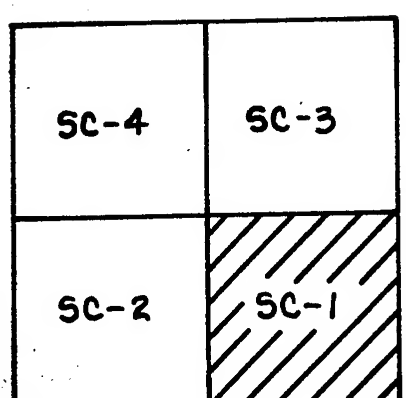
	DATE	B		DATE
	BY	12		BY





KEY PLAN

ETHERN

SYSTEMScor

SYSTEMS ENGINEERING
KNOXVILLE, TENNESSEE

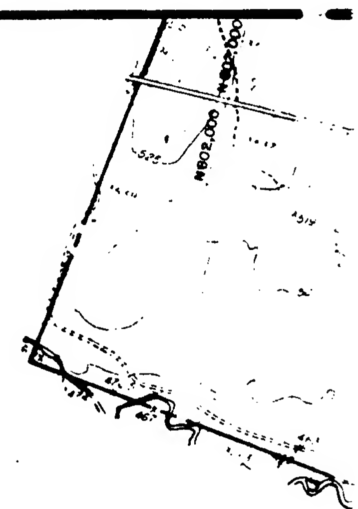
DATE	A	13	DRAWN BY	JOB
BY			CHECKED BY	CAD

ETHERNET FIBER OPTIC NETWORK

SYSTEMScorp

SYSTEMS ENGINEERING AND MANAGEMENT CORPORATION
KNOXVILLE, TENNESSEE 37919

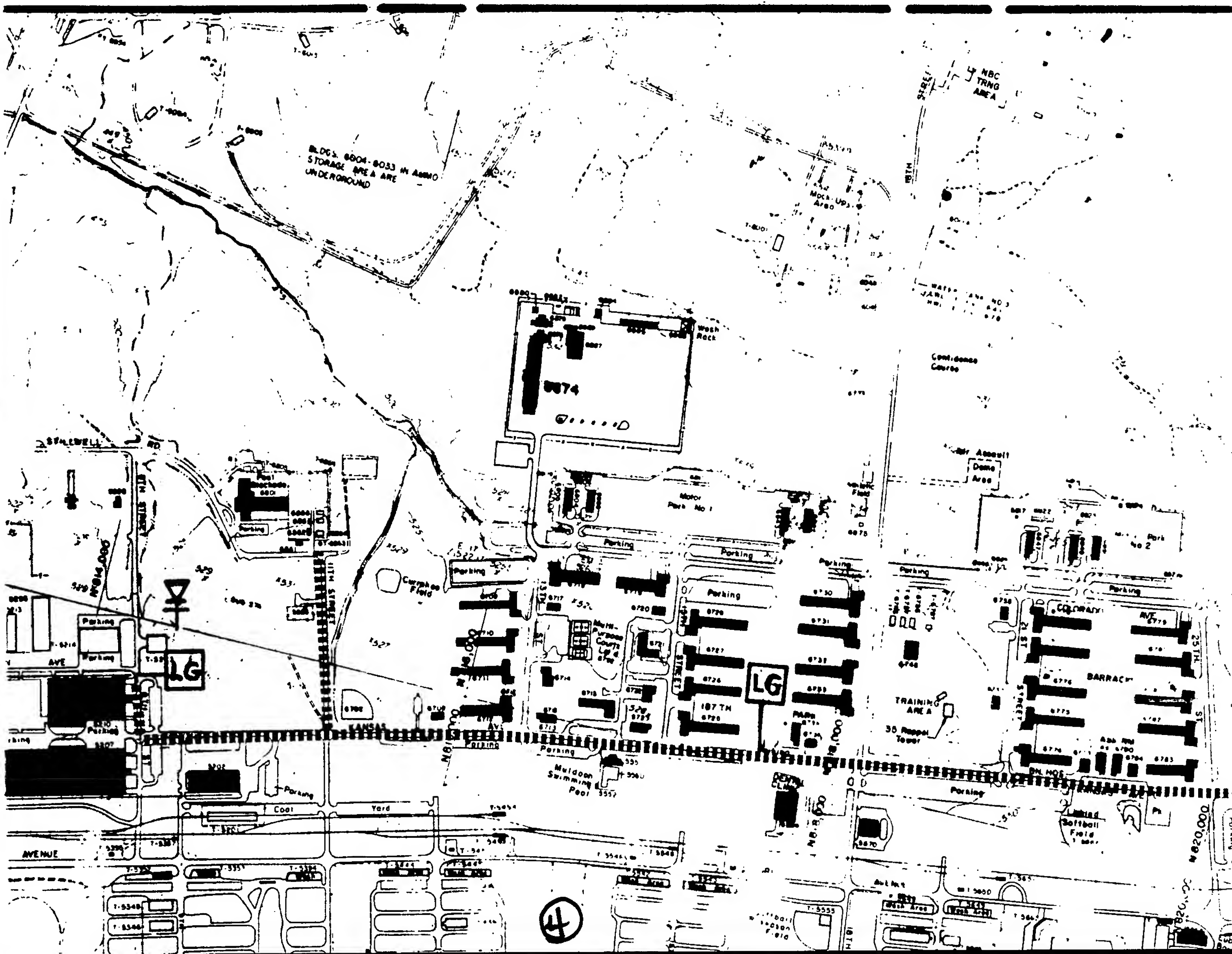
DRAWN BY	JOB NO.	ISSUE DATE	SHEET NO.
CHECKED BY	CAD FILE NO.	PLOT DATE	OF SC-1



[redacted] 1

N 804,000
N 806,000
N 808,000
OKLAHOMA
TEXAS
LOOP
OLD CONSTRUCTION ROAD
SERVICE ROAD
PATROL ROAD
FENCE ROAD
POWER LINE SERVICE
E1,574,000
WOODLAWN

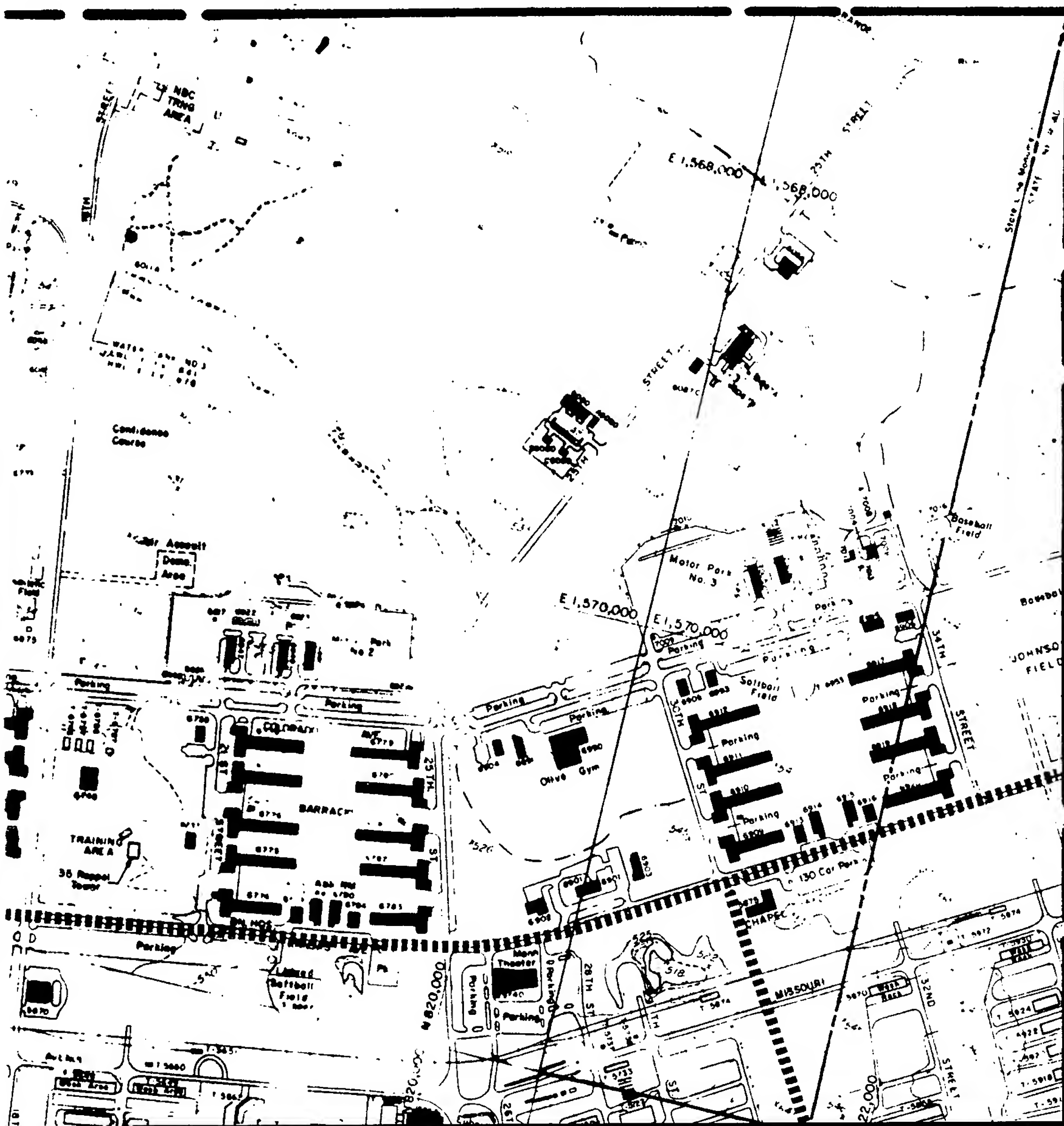
CALIFORNIA
ROAD
SERVICE
LINE
POWER
OLD
FORT CAMPBELL
SEWAGE DISPOSAL
Sanitary Fill
RAIL
FENCE
PATROL
ROAD
MABRY
STILLWELL
RD
8TH STREET
N812,000
N814,000
E1,574,000
Salvage Yard
Parking
OREGON
AVE
KANSAS
AVENUE
POL
MISSOURI
AVENUE
POW Cem
WEST
FORK
CREEK
3



NBC TRNG AREA
BLDGS. 6004-6033 IN AMMO STORAGE AREA ARE UNDERGROUND
Mock-Ups Area
Wash Rack
6874
Confidence Course
Air Assault Dome Area
STILWELL RD
Motor Park No 1
Parking
11TH STREET
KANSAS
Muldoon Swimming Pool
TRAINING AREA
BARRACKS
COLORADO AVE
187TH
LG
Coal Yard
AVENUE
Softball Field
Wash Area
4

MATCH LINE SEE SHEET
SC-4 FOR CONTINUATION

MATCH LINE SEE SHEET
SC-3 FOR CONTINUATION



MATCH LINE SEE SHEET
SC-1 FOR CONTINUATION

5

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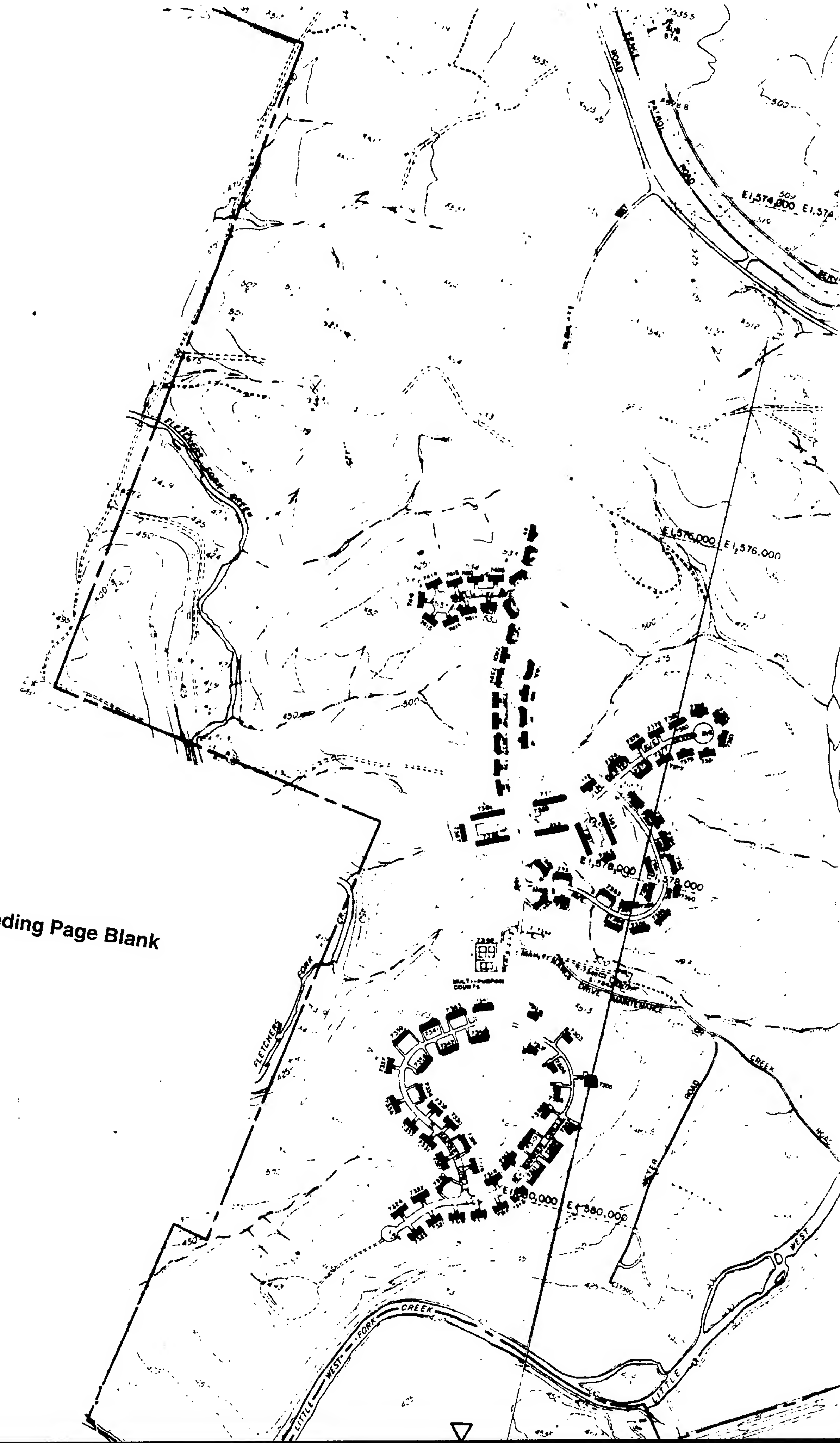
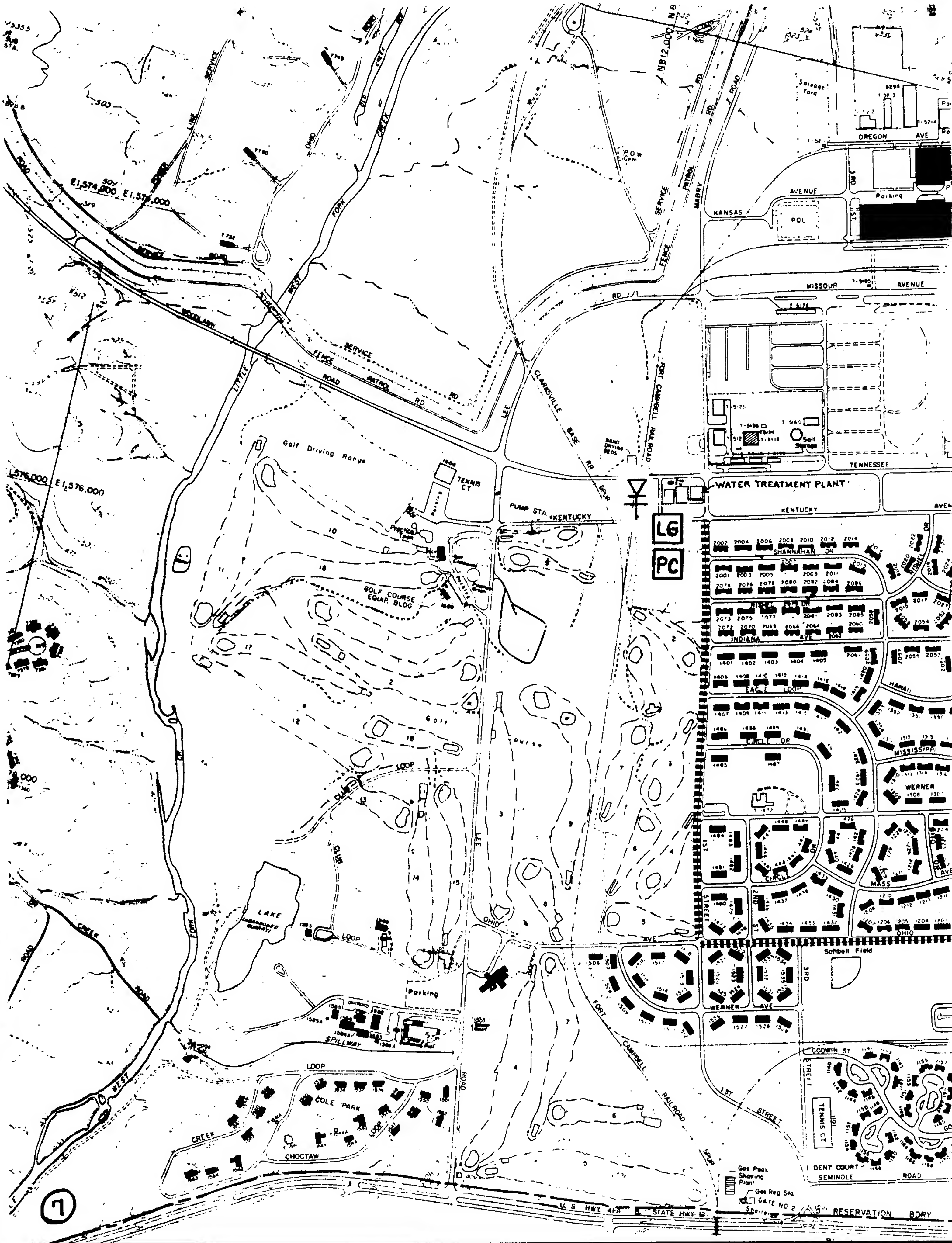
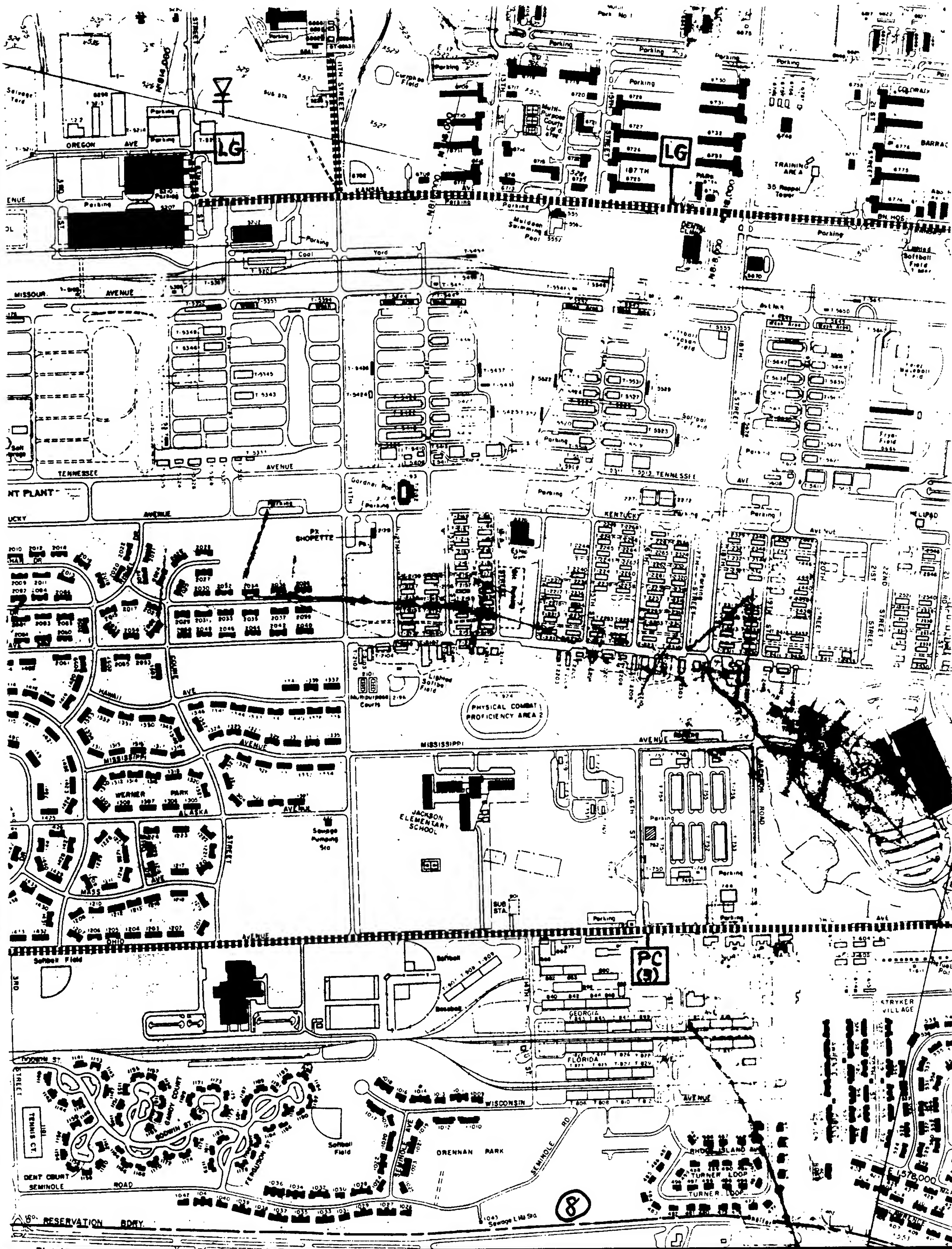


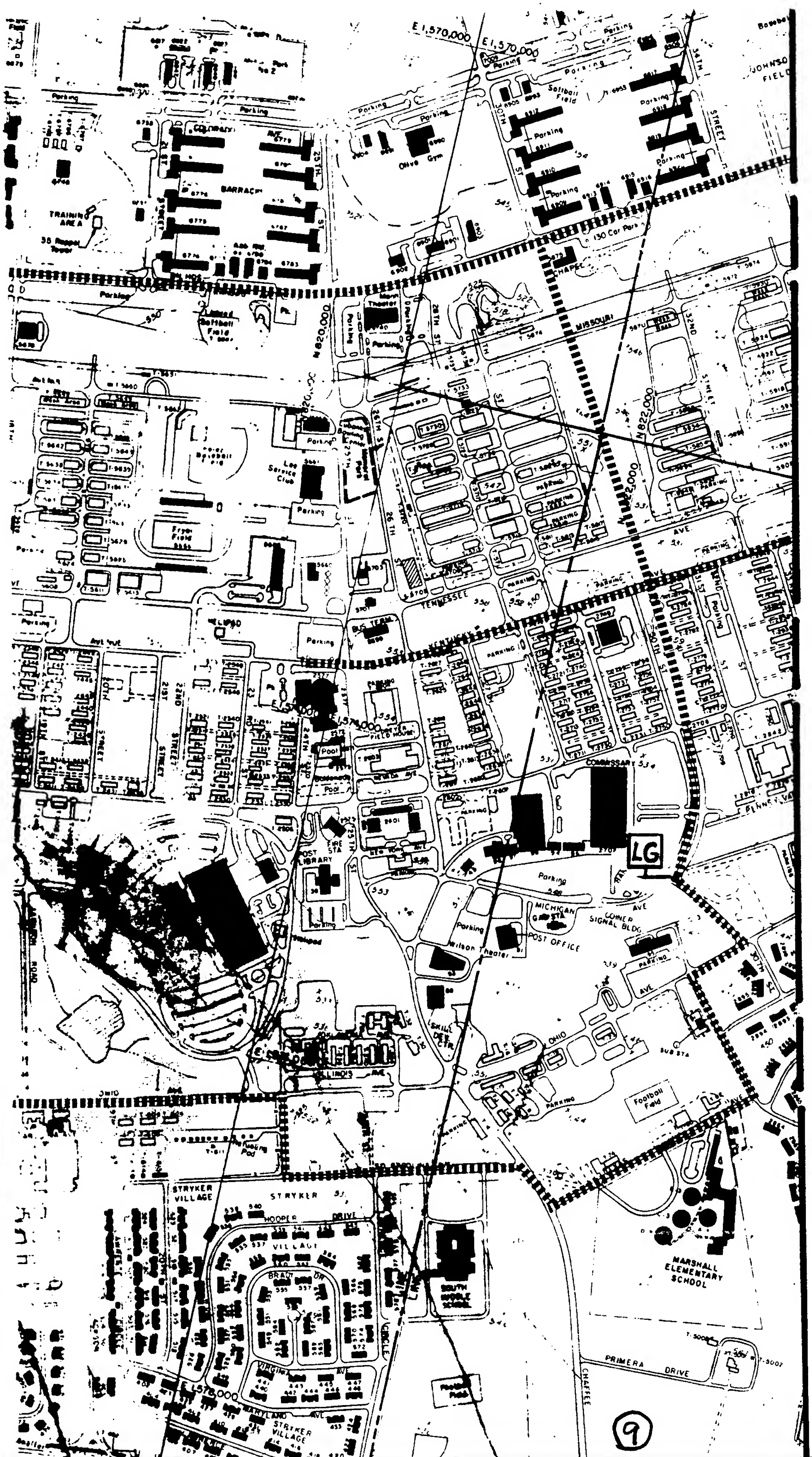
6


WATER TREATMENT PLANT
LG
PC
KENTUCKY
AVENUE
TENNESSEE
MISSOUR
OREGON
AVE
KANSAS
POL
Salvage Yard
Parking
P O W Cem
SERVICE
PATROL
MABRY
FENCE
RD
ROAD
FORT CAMPBELL RAILROAD
CLARKSVILLE BASE RR SPUR
LEE
WOODLAWN
ROAD
SERVICE
FENCE
PATROL
RD
LITTLE
WEST
FORK
CREEK
OHIO
OLD
LINE
SERVICE
E1,574,000
E1,576,000
Golf Driving Range
TENNIS CT
Parking
PUMP STA.
Practice Tees
GOLF COURSE EQUIP. BLDG
Golf
Course
CLUB
LOOP
LAKE
Parking
SPILLWAY
LOOP
COLE PARK
CREEK
CHOCTAW
ROAD
OHIO
AVE
FORT
CAMPBELL
RAILROAD
SPUR
1ST
STREET
SHANNAHAN DR
INDIANA
AVE
EAGLE LOOP
CIRCLE DR
HAWAII
MISSISSIPPI
WERNER
MASS
OHIO
Softball Field
WERNER AVE
3RD
CODWIN ST
TENNIS CT
DENT COURT
SEMINOLE
ROAD
Gas Peak Shaving Plant
Gas Reg Sta.
GATE NO 2
U. S. HWY. 41A
STATE HWY 12
RESERVATION BDRY

7



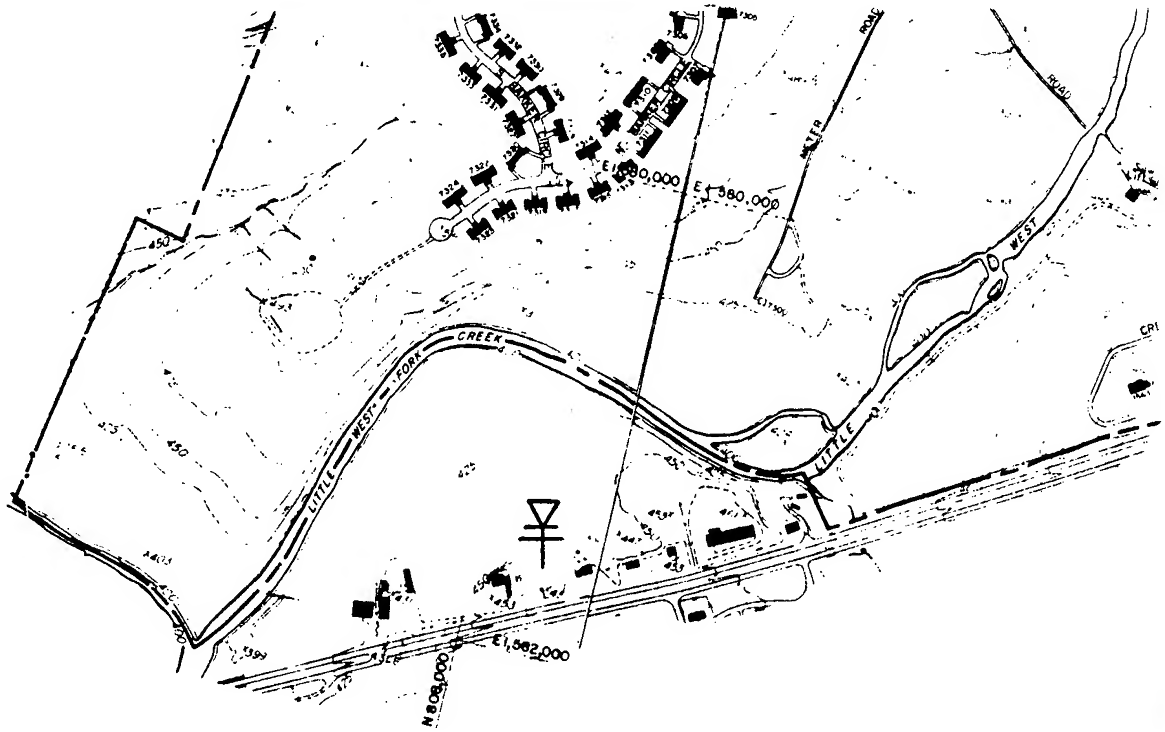
OREGON AVE
LG
11TH STREET
Curraghoe Field
Multi-Purpose Courts
187 TH
TRAINING AREA
38 Rappel Tower
Muldoon Swimming Pool
DENTAL CLINIC
Coal Yard
MISSOURI AVENUE
Lighted Softball Field
TENNESSEE AVENUE
Softball Field
Gardner Pool
Parking
PX SHOPETTE
KENTUCKY
HELIPAD
PHYSICAL COMBAT PROFICIENCY AREA 2
Multipurpose Courts
Lighted Softball Field
HAWAII AVE
MISSISSIPPI AVENUE
WERNER PARK
ALASKA AVENUE
JACKSON ELEMENTARY SCHOOL
Sewage Pumping Sta
SUB STA.
JACKSON ROAD
OHIO AVENUE
PC (5)
Softball Field
Softball
Baseball
GEORGIA
FLORIDA
WISCONSIN
STRYKER VILLAGE
TENNIS CT
DENT COURT
SEMINOLE ROAD
GOODWIN ST.
SEMINOLE AVE
DRENNAN PARK
RHODE ISLAND AVE
TURNER LOOP
RESERVATION BDRY
8



E 1,570,000
JOHNSON FIELD
Softball Field
Parking
Olive Gym
STREET
BARRACKS
TRAINING AREA
COLORADO AVE
Chapel
130 Car Park
Main Theater
Lighted Softball Field
MISSOURI
N 820,000
N 822,000
26TH ST
32ND
Lee Service Club
Fryer Field
TENNESSEE
KENTUCKY
BUS TERM
HELIPAD
Parking
21ST
22ND
STREET
FIELD HOUSE
Pool
COMMISSARY
POST LIBRARY
FIRE STA
LG
MICHIGAN
GAS STA
POST OFFICE
CONNER SIGNAL BLDG
Wilson Theater
SKILL DEV CTR
OHIO
ILLINOIS AVE
SUB STA
Football Field
STRYKER VILLAGE
STRYKER
HOOPER DRIVE
VILLAGE
BRAGG DR
VIRGINIA AV
MARYLAND AVE
E 1,578,000
SOUTH MIDDLE SCHOOL
MARSHALL ELEMENTARY SCHOOL
PRIMERA DRIVE
CHAFFEE
CIRCLE

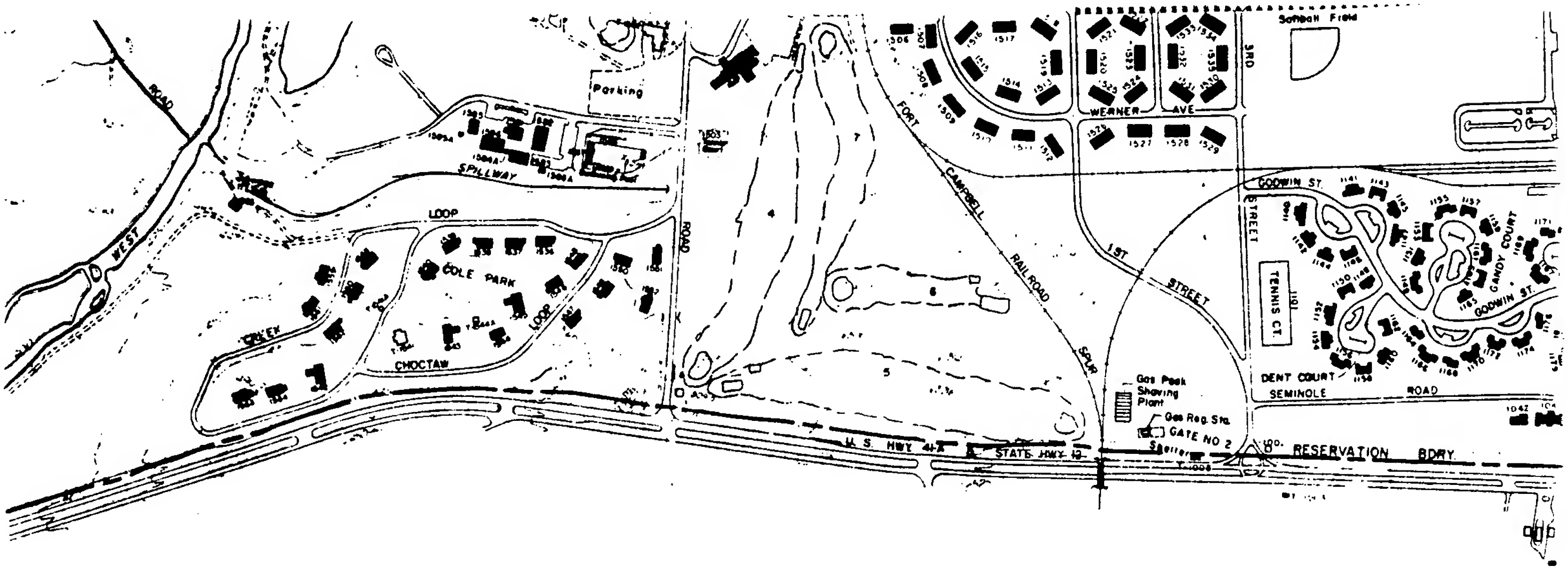
	DATE	D
	BY	

10


LITTLE WEST FORK CREEK
LITTLE WEST
E1,580,000
E1,582,000
N 808,000
ROAD
450
425

DATE	C
BY	

11



LEGEND

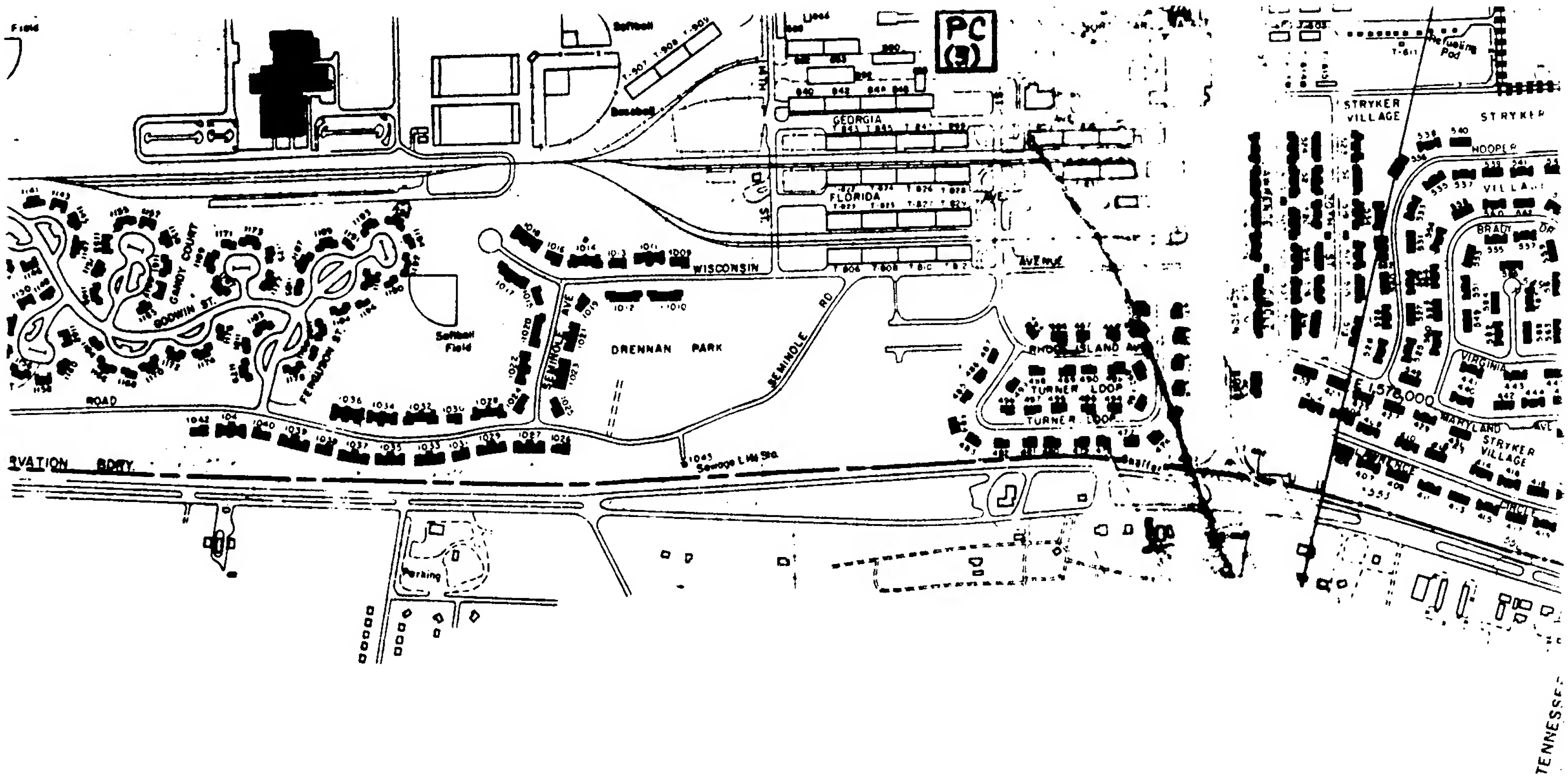
SYMBOL	DESCRIPTION
	FIBER OPTIC NETWORK
	WIRELESS COMMUNICATION
LG	LANGATE (NETWORK INTERFACE)
PC	COMPUTER MONITOR/ CONTROL STATIONS

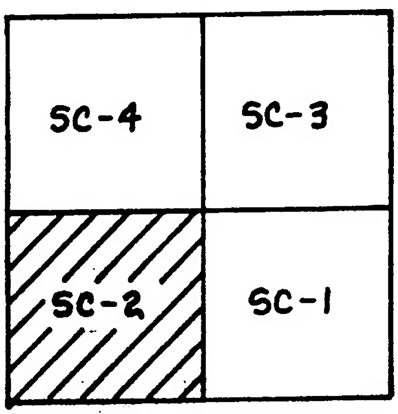
SC-

SC-

KE

	DATE	B		DATE
	BY			BY





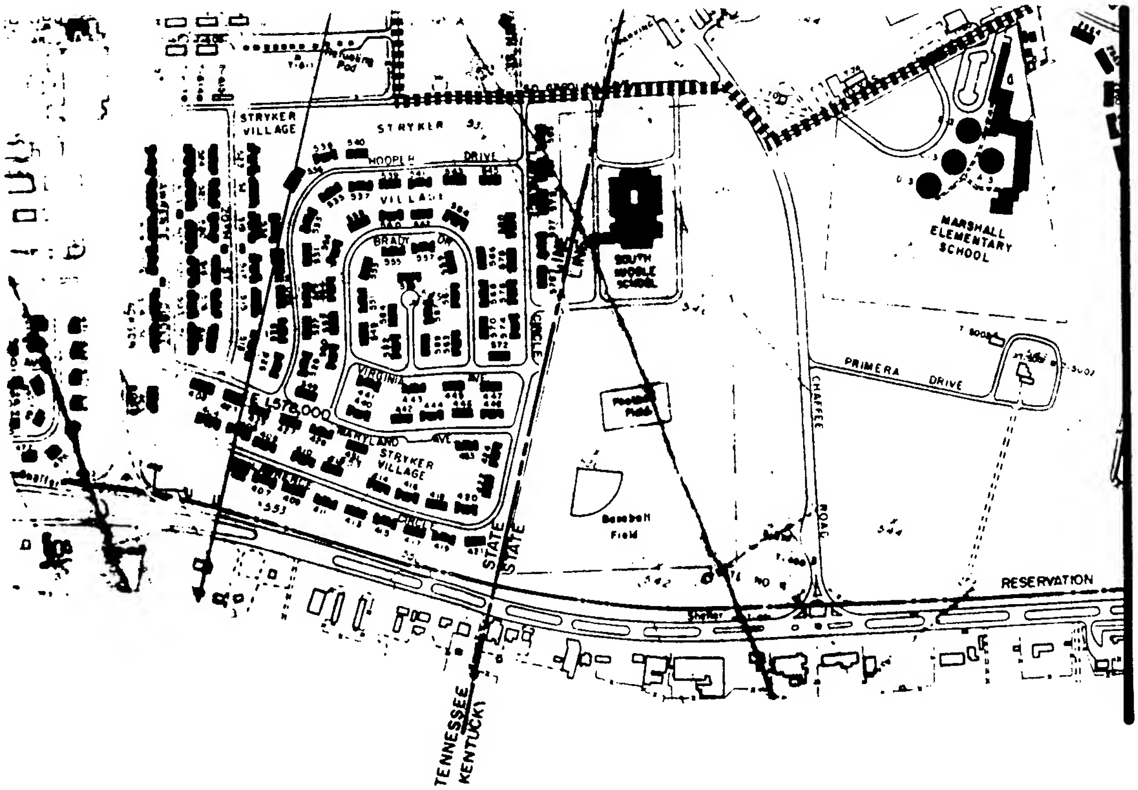
KEY PLAN

ETHERNET

SYSTEMScorp

SYSTEMS ENGINEERING AND
KNOXVILLE, TENNESSEE 37

DATE	A	DRAWN BY	JOB NO.
BY		CHECKED BY	CAD FILE

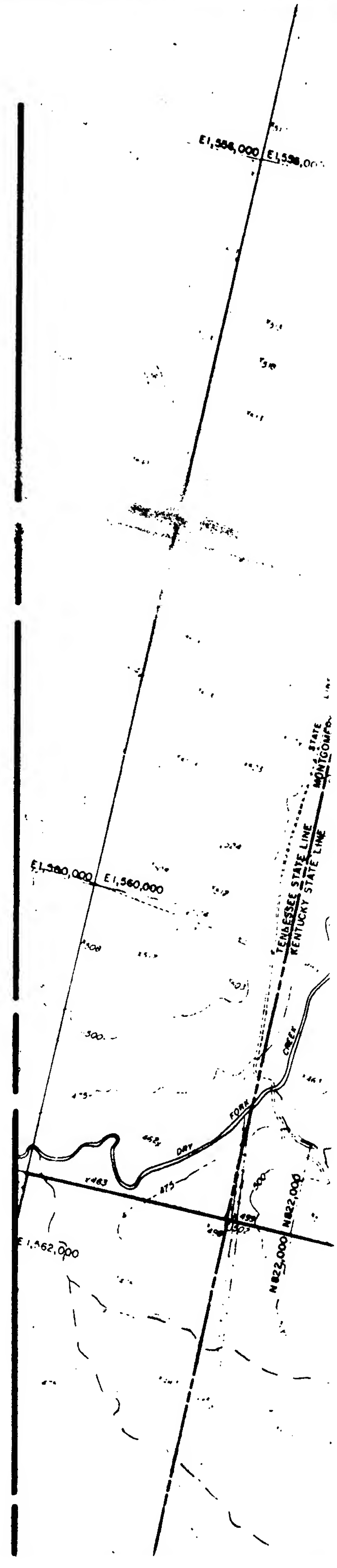


ETHERNET FIBER OPTIC NETWORK

SYSTEMS*corp*

SYSTEMS ENGINEERING AND MANAGEMENT CORPORATION
KNOXVILLE, TENNESSEE 37919

RAWN BY	JOB NO.	ISSUE DATE	SHEET NO. SC-2
HECKED BY	CAD FILE NO.	PLOT DATE	OF



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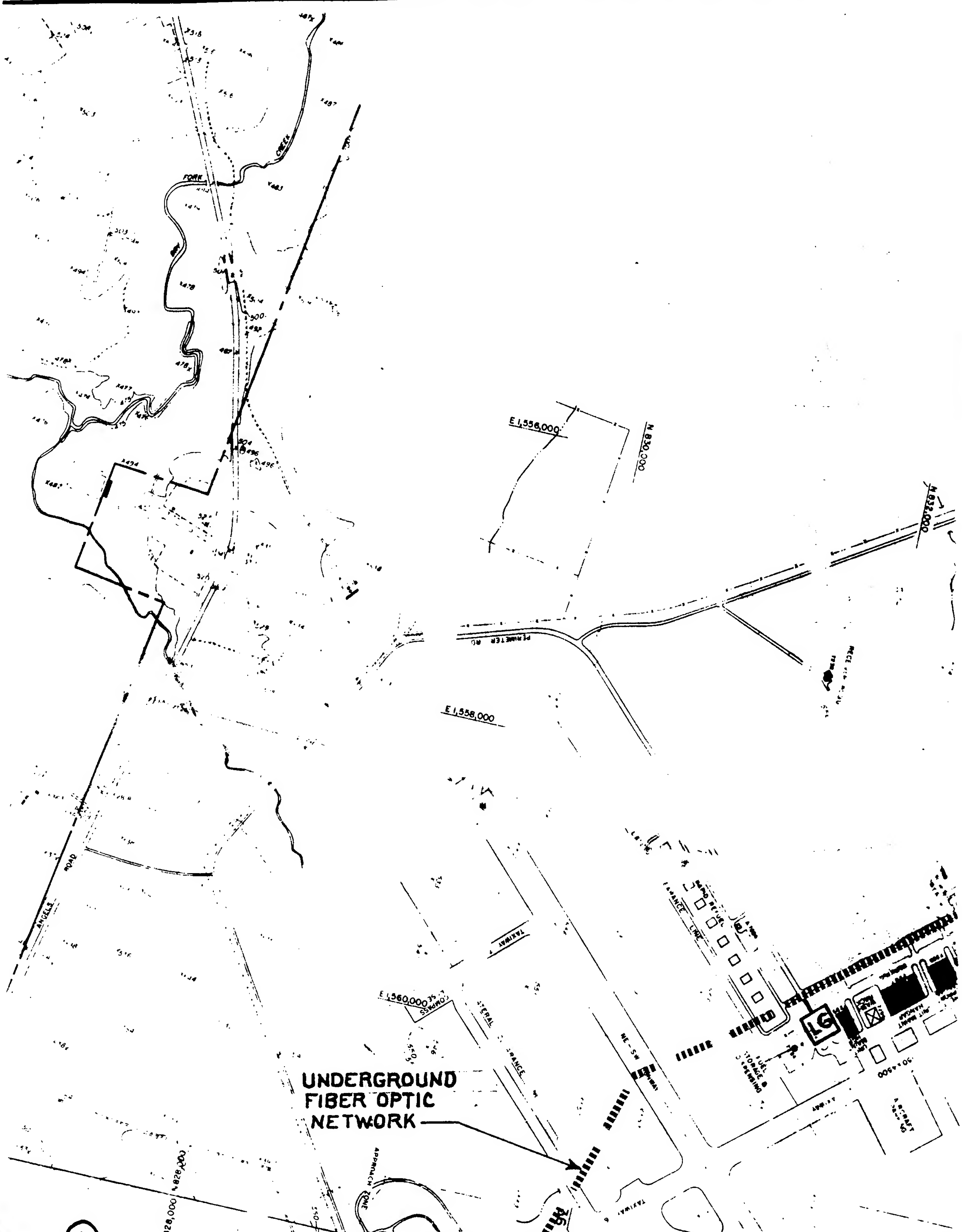
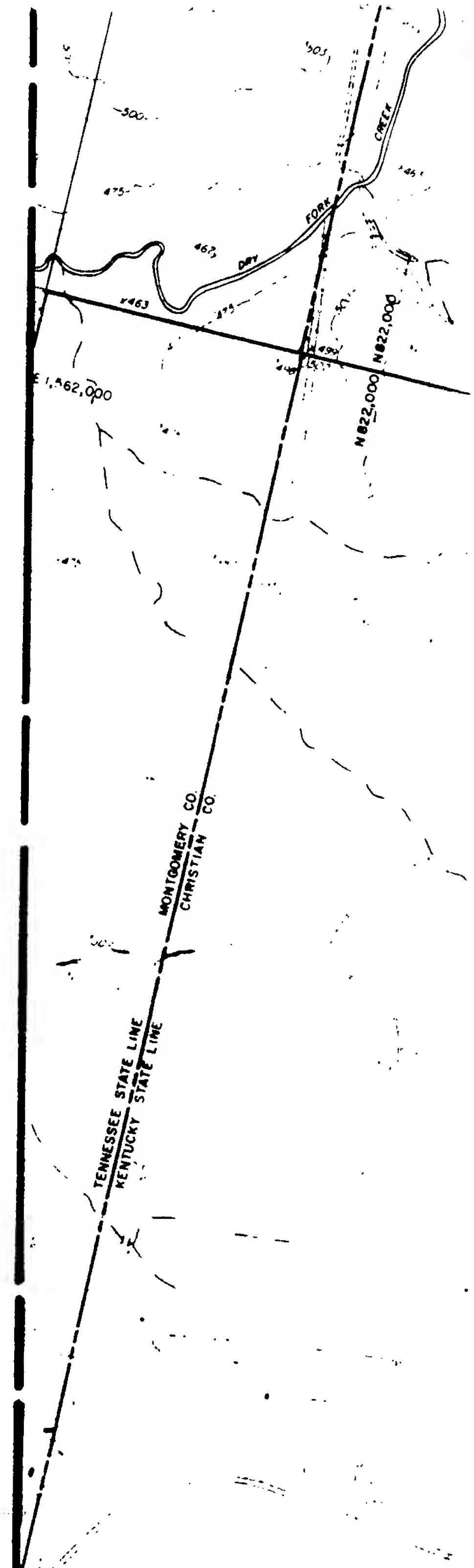
E1,556,000
STATE LINE
MONTGOMERY CO
CHRISTIAN CO
TENNESSEE STATE LINE
KENTUCKY STATE LINE
DRY FORK CREEK
N822,000
N824,000
N826,000
ROAD

2


UNDERGROUND
FIBER OPTIC
NETWORK
E 1,556,000
N 830,000
N 832,000
E 1,558,000
E 1,560,000
PERIMETER RD
ANGELS ROAD
FORK
CREEK
N 828,000
APPROACH ZONE
LG

3


N 832,000



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SC-4 FOR CONTINUATION

MATCH LINE SEE SHEET
SC-2 FOR CONTINUATION

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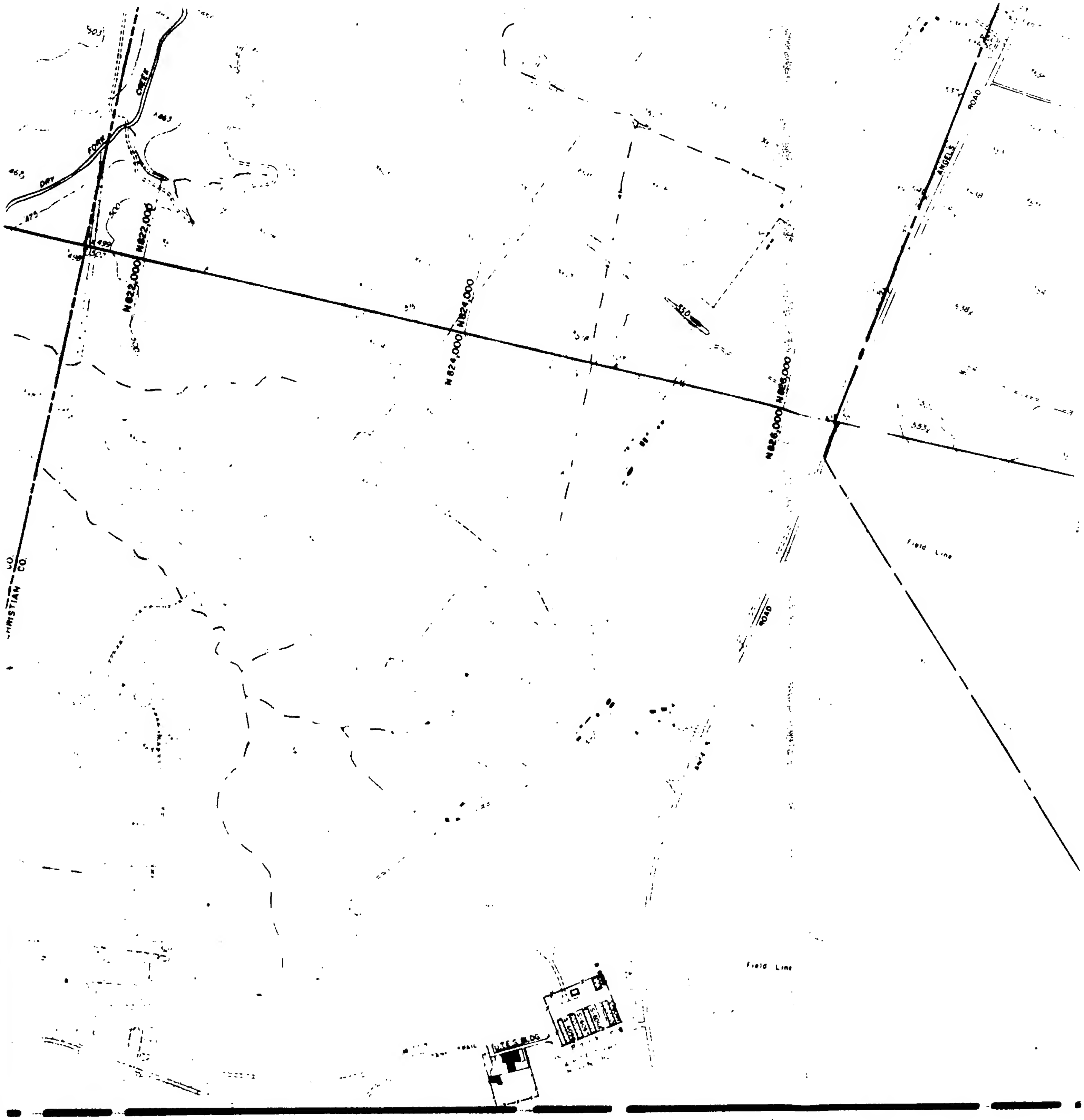
SC-1 FOR CONTINUATIO



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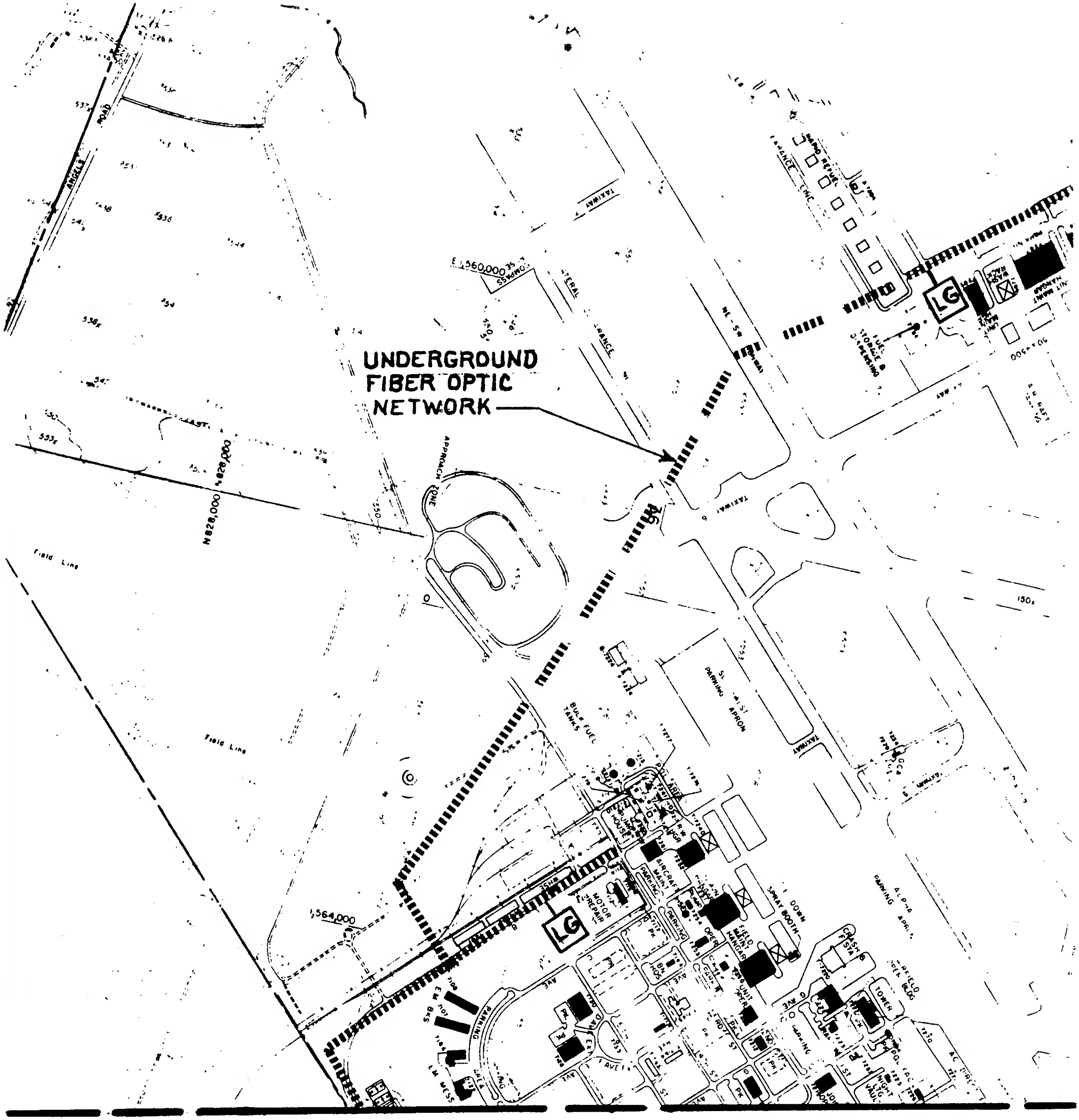
'OR CONTINUATION


UNDERGROUND
FIBER OPTIC
NETWORK
LG
LG
APPROACH ZONE
BULK FUEL TANKS
PARKING APRON
AIRCRAFT MAINT
FIELD MAINT HANGAR
MOTOR REPAIR
SPRAY BOOTH
CRASH STA
TOWER
TAXIWAY
E 1,560,000
1,564,000
N628,000
Field Line
Field Line
E M BKS
E M MESS


BOILER PLANT
LG
LATERAL CLEARANCE
150'
N-S FW RUNWAY N0°16'23"E
18
22

DATE

BY

D

MATCH LINE SEE SHEET
SC-4 FOR CONTINUATION

MATCH LINE SEE SHEET
SC-2 FOR CONTINUATION

MATCH LINE SEE SHEET
SC-1 FOR CONTINUATION

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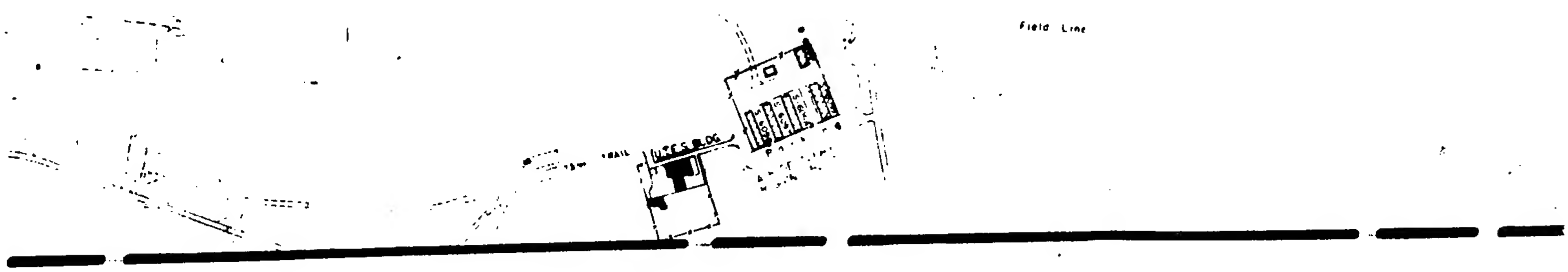

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CONTINUATION

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SYMBOL	DESCRIPTION
	FIBER OPTIC NETWORK
	WIRELESS COMMUNICATION
LG	LANGATE (NETWORK INTERFACE)
PC	COMPUTER MONITOR/ CONTROL STATIONS

DATE	B
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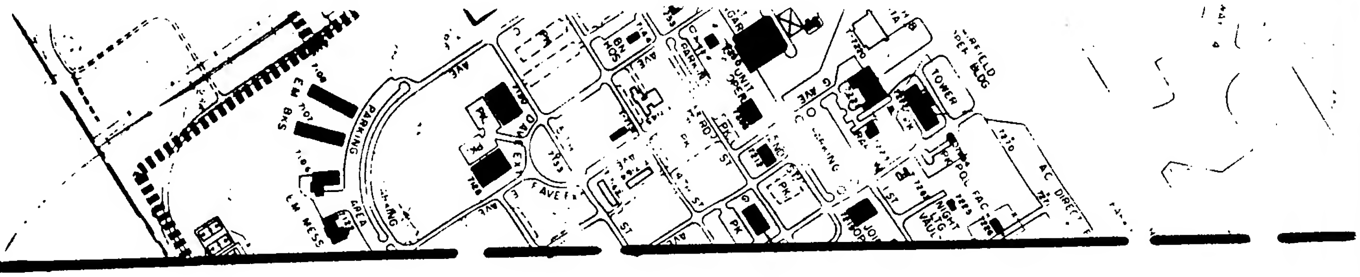

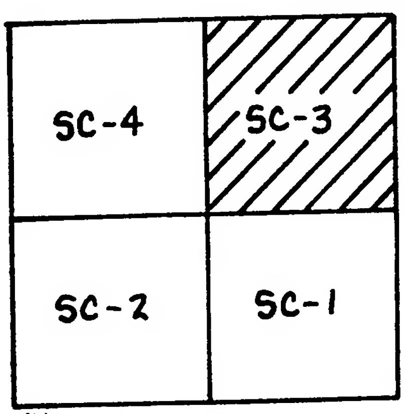

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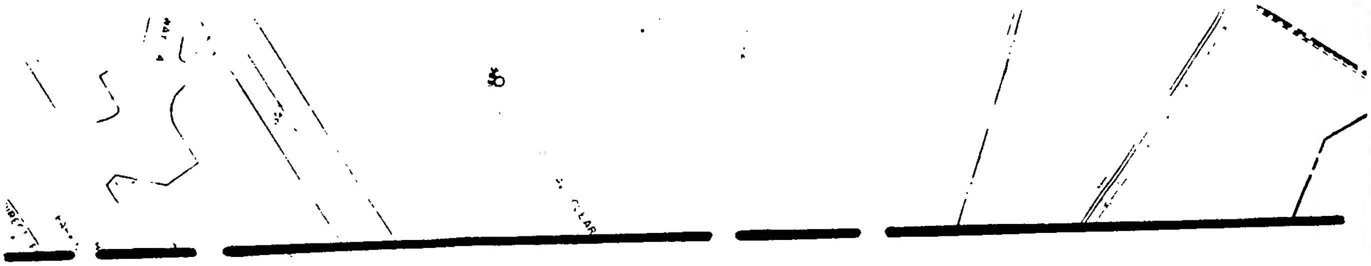

ETHERNET FIBER OPTIC NETWORK

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SYSTEMS ENGINEERING AND MANAGEMENT CORPORATION
KNOXVILLE, TENNESSEE 37919

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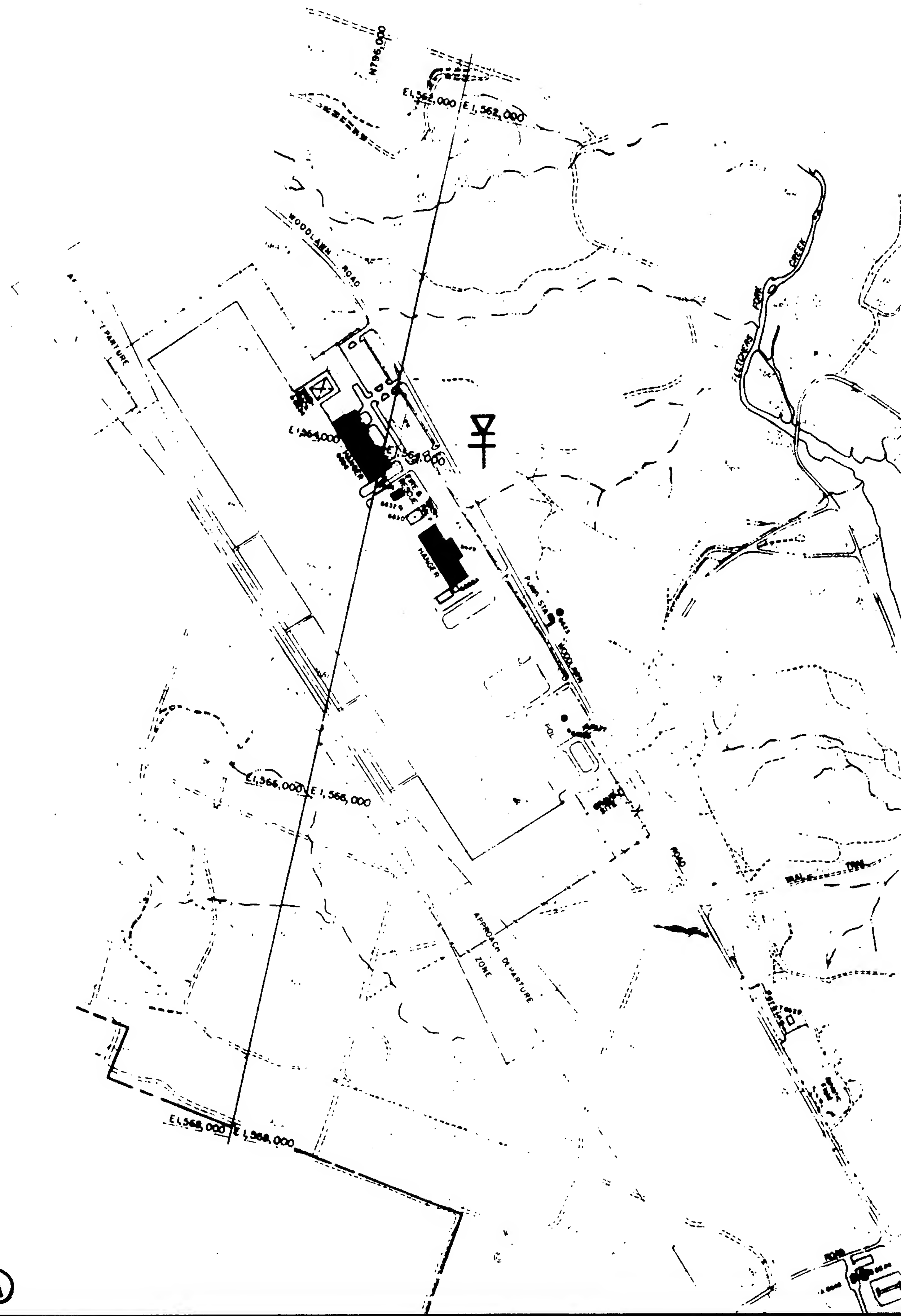
HECKED BY	CAD FILE NO.	PLOT DATE	OF SC-3


N796,000
E 1,562,000
E 1,562,000
WOODLAWN ROAD
DEPARTURE
E 1,564,000
E 1,564,000
HANGER
PUMP STA
WOODLAWN
POL
E 1,566,000
E 1,566,000
ROAD
APPROACH DEPARTURE ZONE
LEEPERS FORK CREEK
E 1,568,000
E 1,568,000

1

LAKE
TRAIL
SPANGLER
LOOP
JORDAN
SPRINGS
ROAD
SCOUT
TRAIL
CAMP
ARMY
TRAVEL CAMP
NATURE CENTER
PUMP STA
CREEK
Riding Stables
Foot bridge
N 804,000
MCNAIR
ROAD

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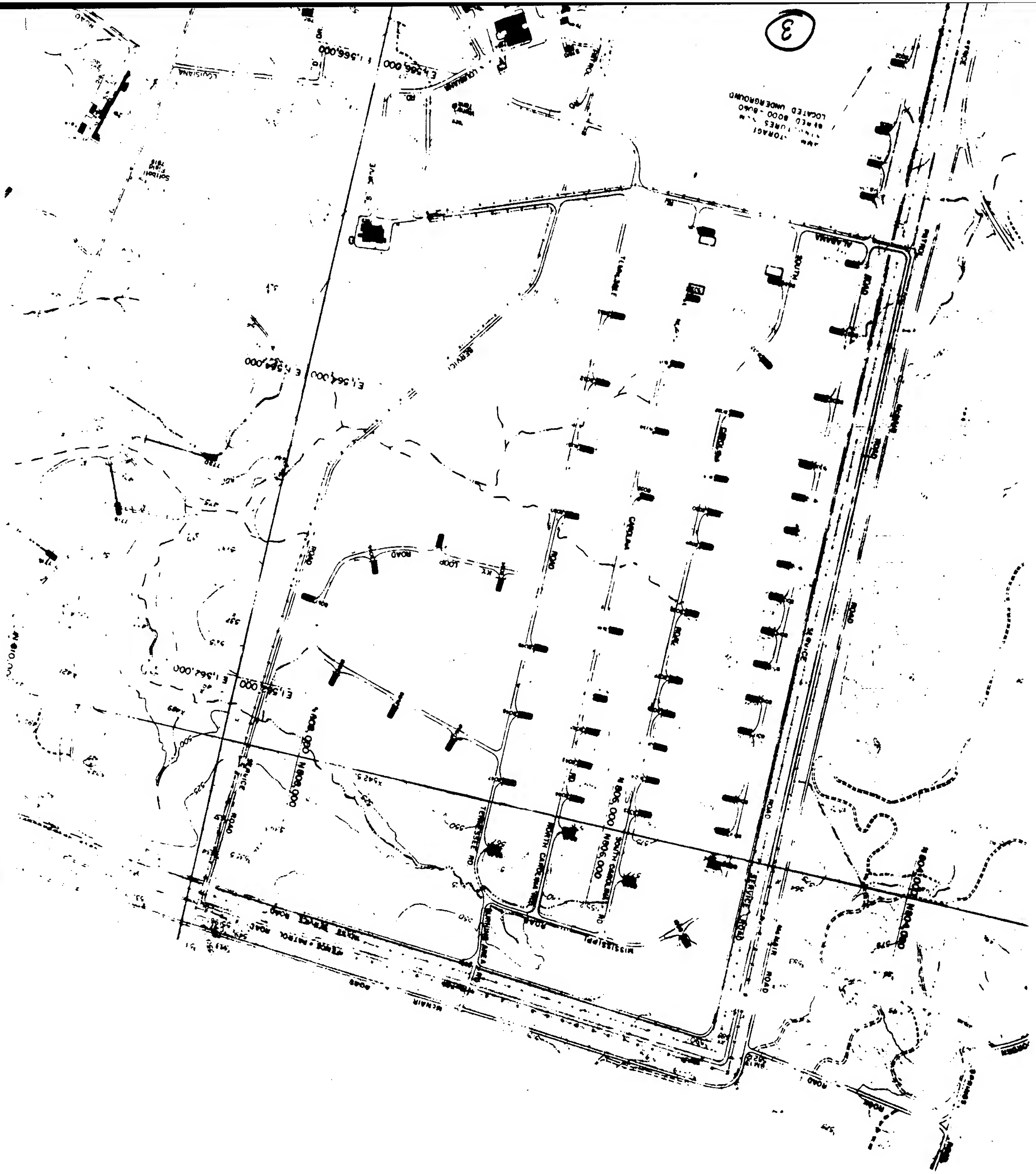
3




McNAIR ROAD
WEST END ROAD
FENCE PATROL ROAD
TRANSMITTER ROAD
SERVICE ROAD
N810,000
N812,000
N814,000
E 1,364,000
GEORGIA
INTERIOR FENCE PATROL
Swimming Pool
Football Field
Softball Field
LOUISIANA
ROAD

BOILING SPRINGS PUMPING STATION
DRY FORK CREEK
MABRY ROAD
ROAD
N814,000
N816,000
N818,000
FORK
CREEK

DRY FORK CREEK
FORK CREEK
N816,000
N816,000
N818,000
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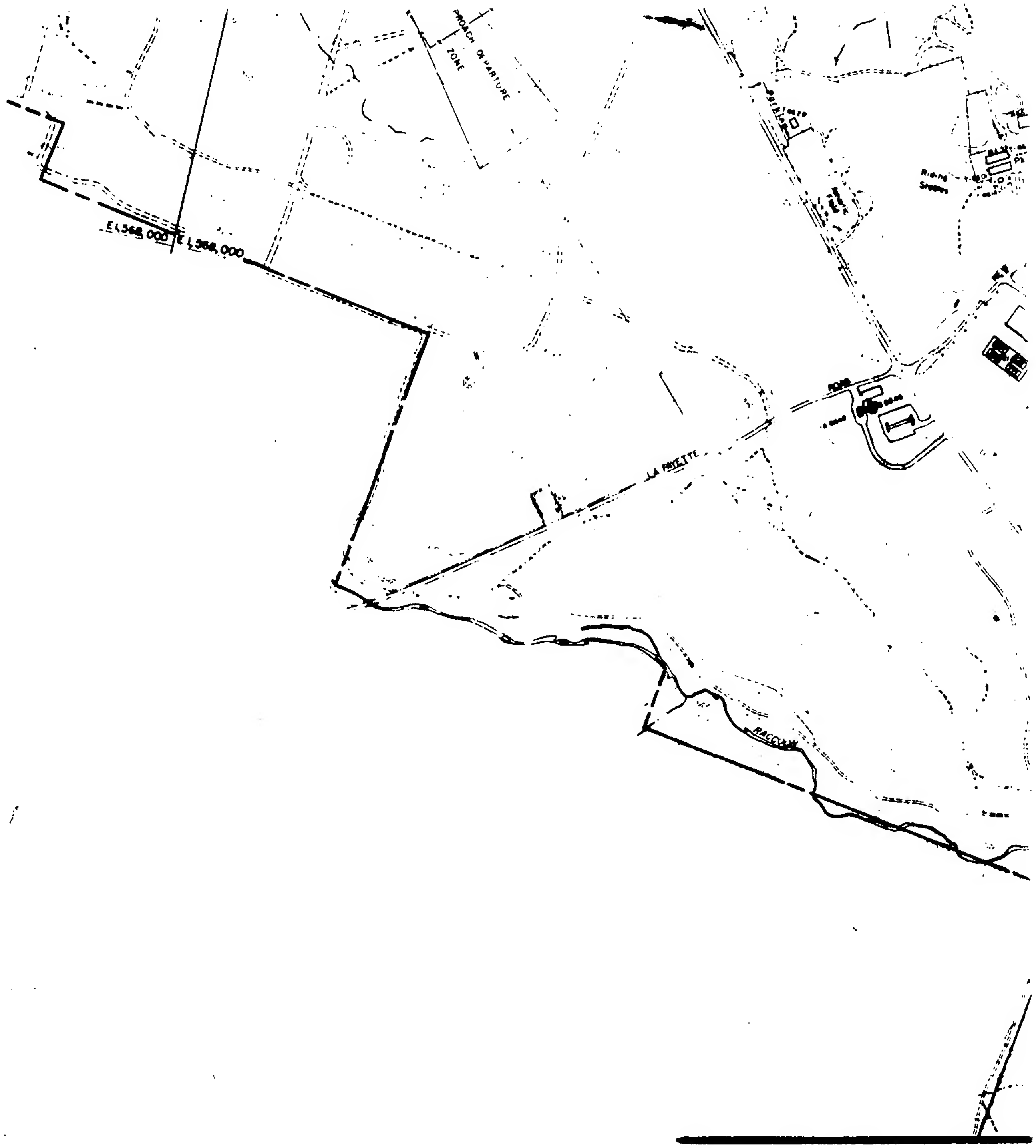
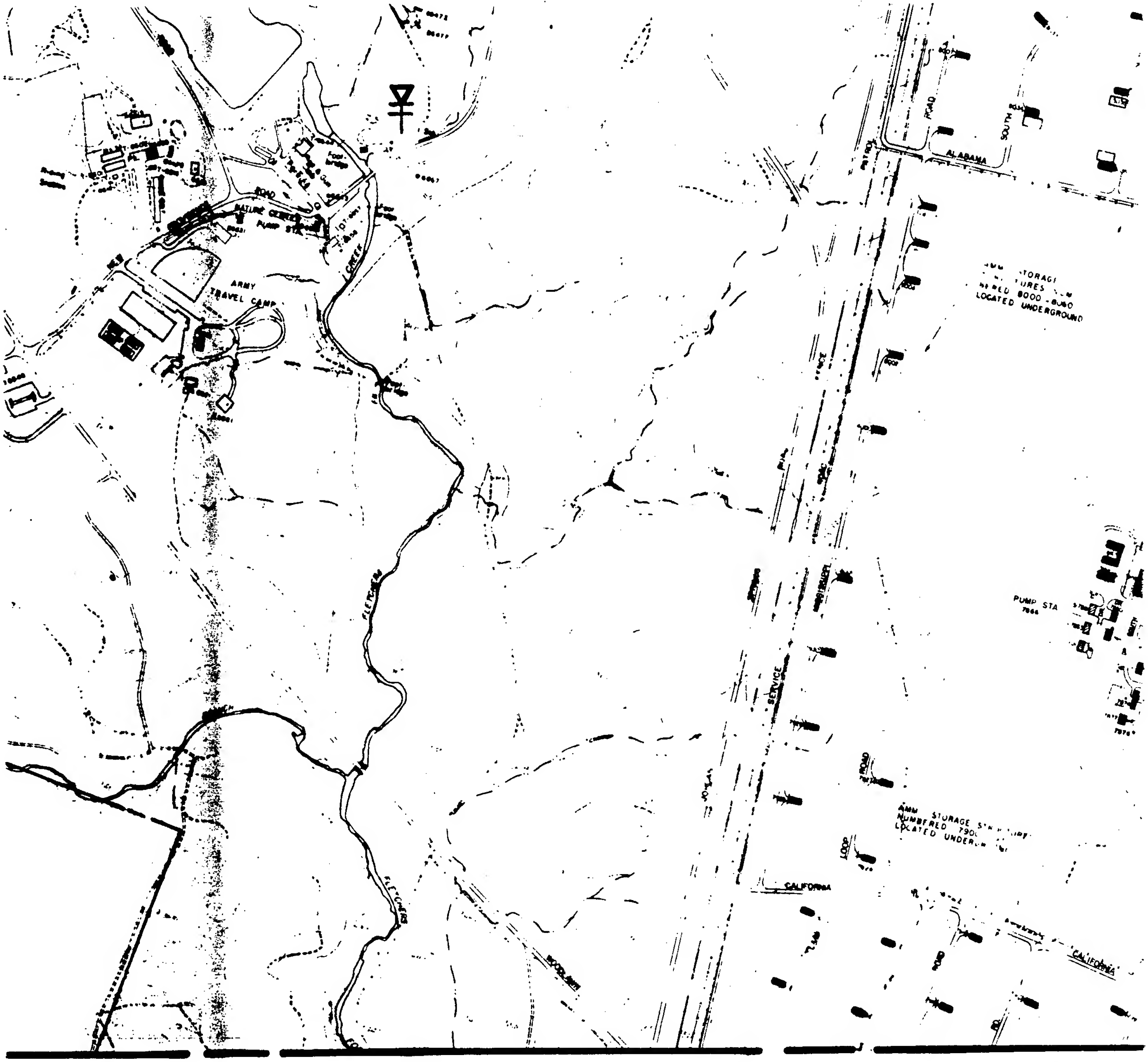
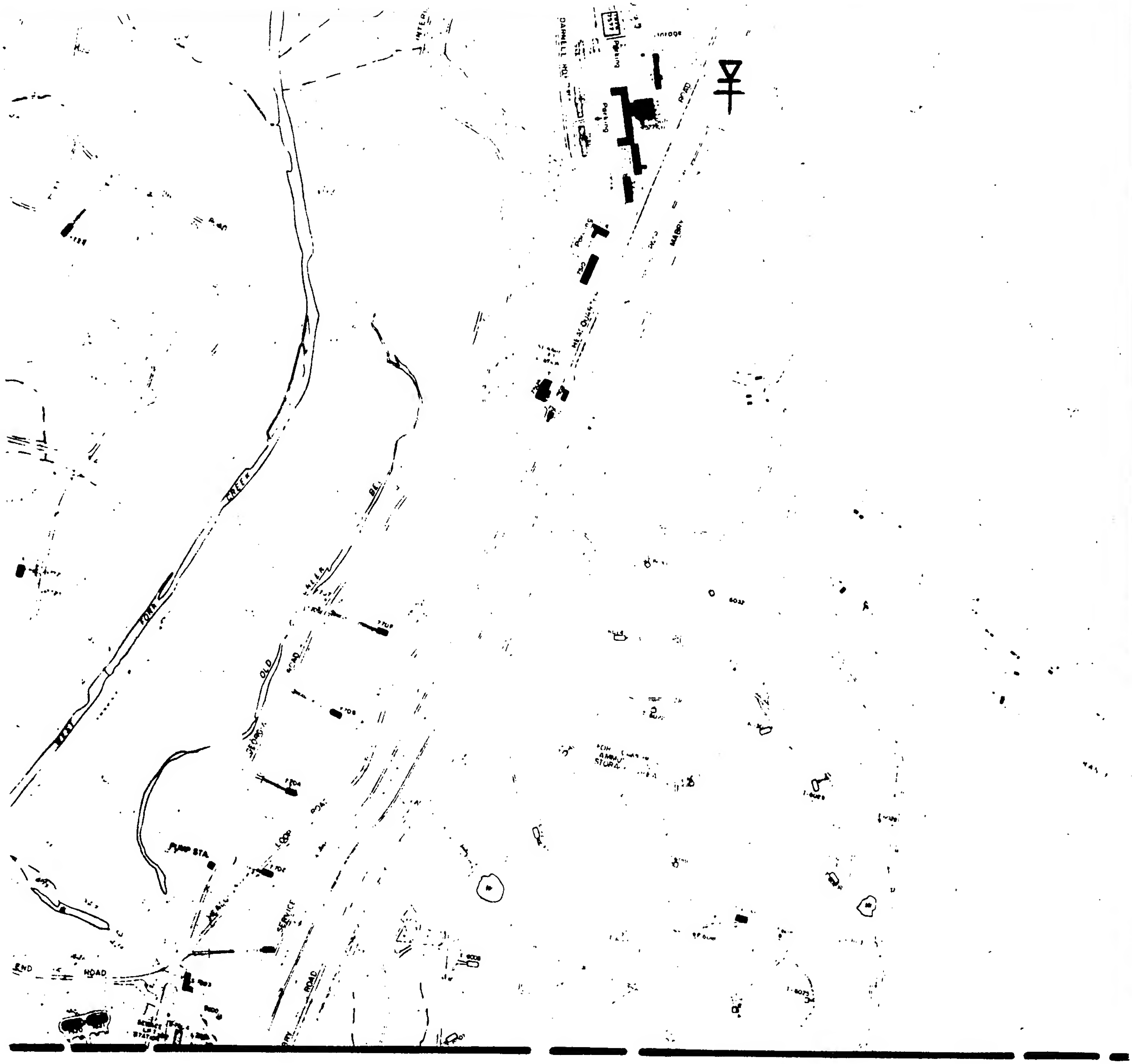
N820,000
N 820,000
E 4,582,000

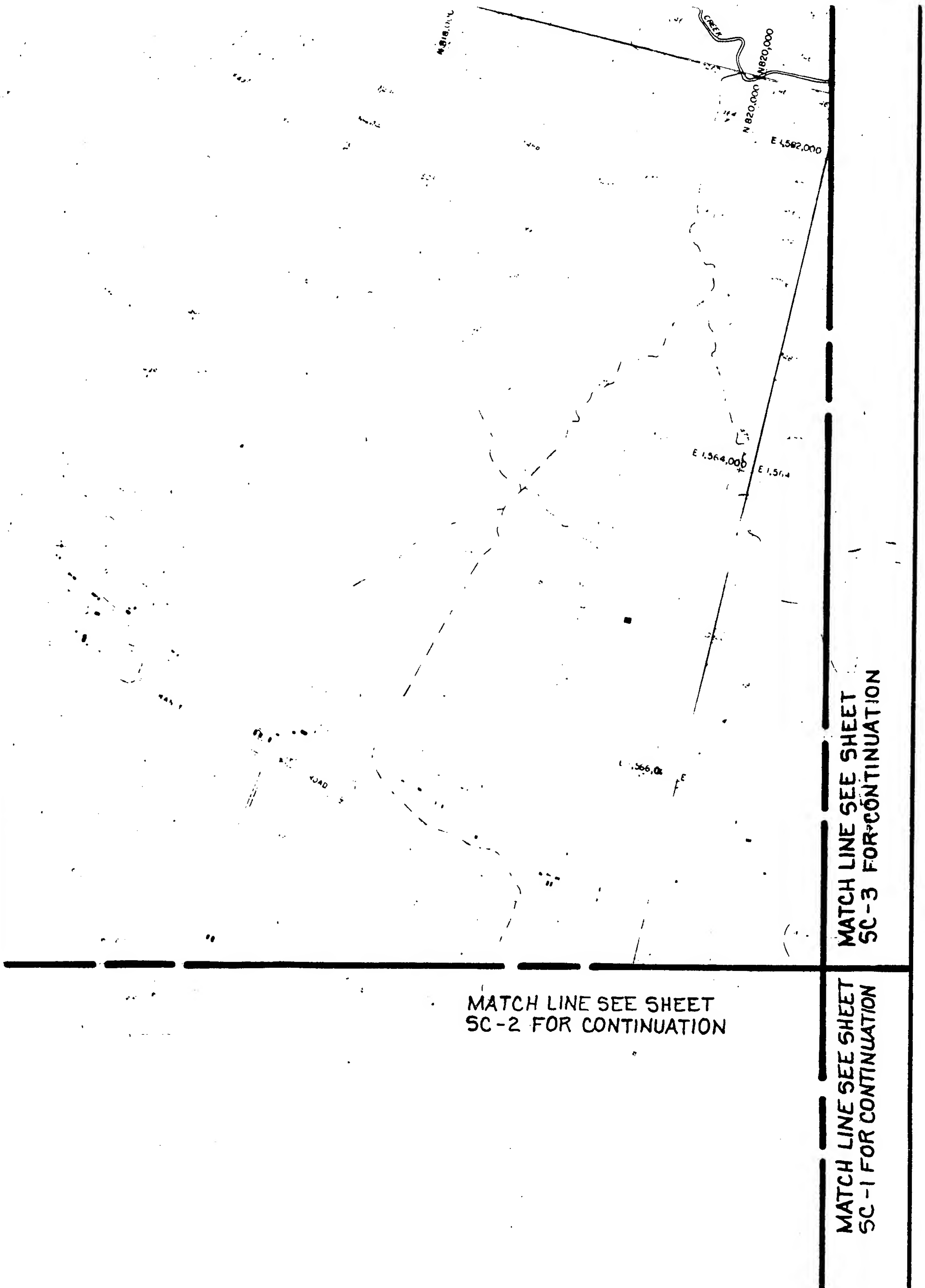
6


APPROACH DEPARTURE
ZONE
E 1,568,000
E 1,568,000
LA FAYETTE
ROAD
Riding
Stables
RACCOON


ROAD
NATURE CENTER
PUMP STA
Foot bridge
ARMY
TRAVEL CAMP
CREEK
FLETCHER
BRANCH
ALABAMA
SOUTH
PATROL
ROAD
LOCATED UNDERGROUND
PUMP STA
SERVICE
ROAD
LOOP
CALIFORNIA
CALIFORNIA
AMM STORAGE
LOCATED UNDER

E 1,564,000
ALABAMA
LOUISIANA
E 1,566,000
PUMP STA.
E 1,568,000
CALIFORNIA
E 1,570,000
POWER LINE SERVICE RD.
PATROL RD.
Softball Field
ROAD
PUMP S


CREEK
FORK
OLD
PUMP STA.
LOOP
SERVICE
ROAD



CREEK
N 820,000
N 820,000
E 1,582,000
E 1,564,000
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SC-2 FOR CONTINUATION
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SC-1 FOR CONTINUATION

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SYMBOL	DESCRIPTION
	FIBER OPTIC NETWORK
	WIRELESS COMMUNICATION
LG	LANGATE (NETWORK INTERFACE)
PC	COMPUTER MONITOR/ CONTROL STATIONS

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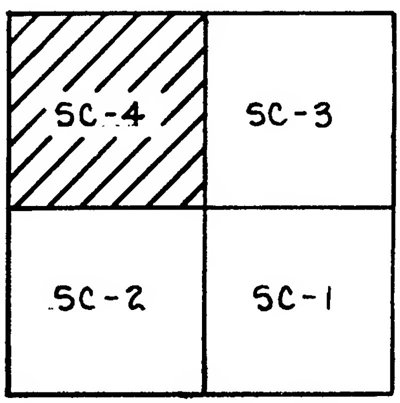

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